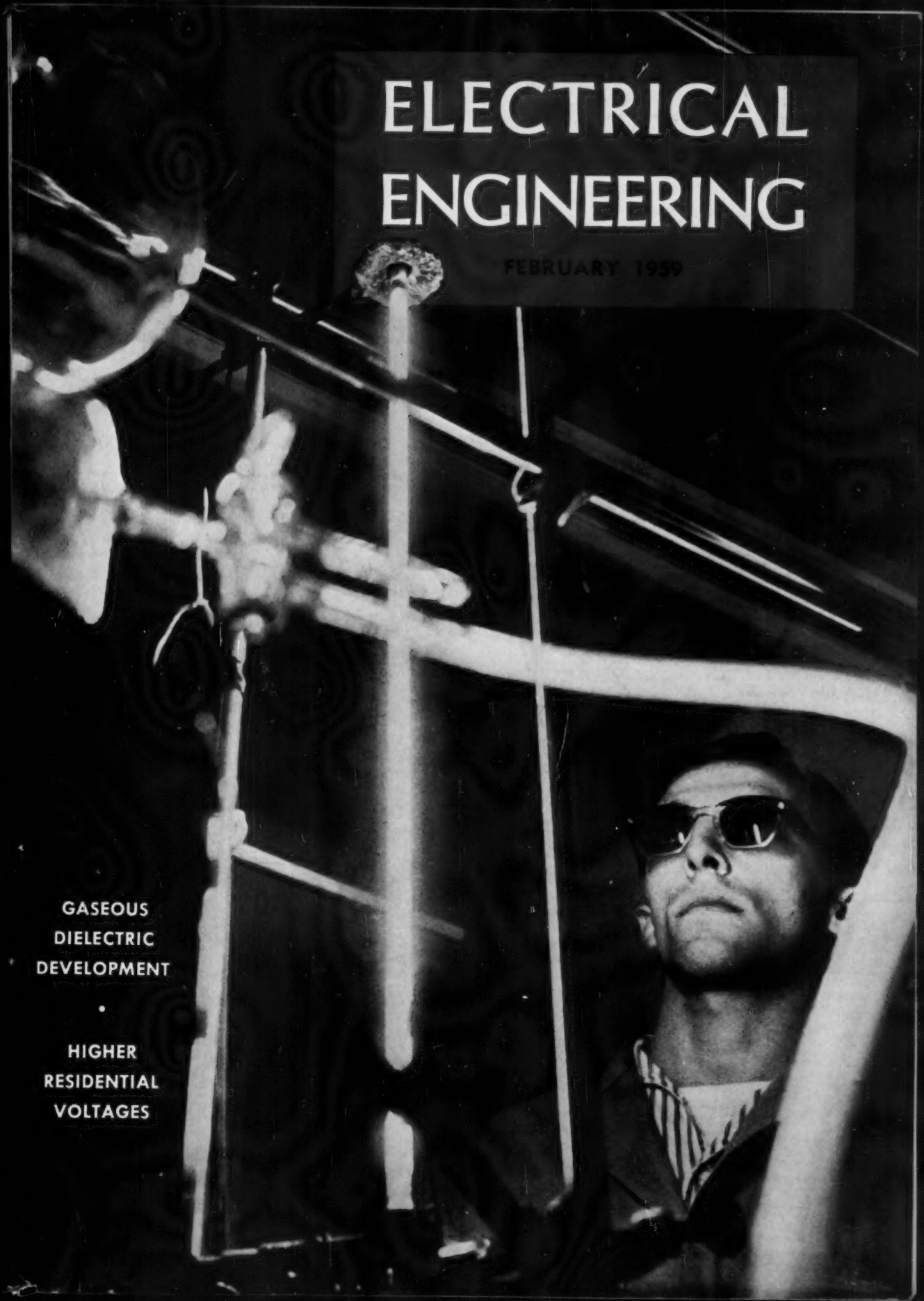
ELECTRICAL ENGINEERING

FEBRUARY 1959



GASEOUS DIELECTRIC DEVELOPMENT

•

HIGHER RESIDENTIAL VOLTAGES

A-B Reliable Control Units

for every industrial application

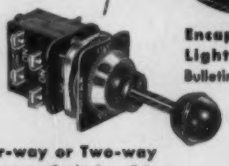
Among the many hundreds of Allen-Bradley push button and control units, you are certain to find the types best suited to your particular needs. The seven units shown below are a few of the latest additions to the Allen-Bradley *quality* line of control units.

All Allen-Bradley control units—standard duty, heavy duty, and oiltight—have double break, silver alloy contacts—to assure reliable operation. Simple constructions and generous wiring room are outstanding features. Insist on Allen-Bradley control units for *all* of your equipment—you can't go wrong!

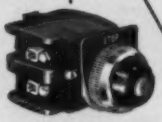
NEW

Illuminated Push Button. Combines pilot light and push button in one unit. Oiltight Bulletin 800T.

Push-to-Test Pilot Light. Oiltight Bulletin 800T.



Four-way or Two-way Selector Switch. Oiltight Bulletin 800T.

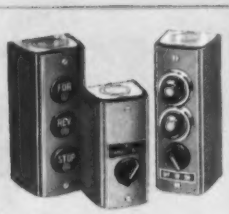


Encapsulated Pilot Light. Heavy Duty Bulletin 800.

Encapsulated Pilot Light. Oiltight Bulletin 800T.

Time Delay Push Button. Delay is adjustable from 0.5 second to 5 seconds. Oiltight Bulletin 800T.

Double Circuit Push Button. Has 2 N.O. or 2 N.C. contacts. Oiltight Bulletin 800T.



STANDARD DUTY CONTROL STATIONS

HEAVY DUTY CONTROL STATIONS

OILTIGHT CONTROL STATIONS

ALLEN-BRADLEY OFFERS the most complete line of standard duty, heavy duty, and oiltight control stations on the market. Send for Publication 6090 today.

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MOTOR CONTROL

QUALITY

Allen-Bradley Co., 1316 S. Second St., Milwaukee 4, Wis.
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ELECTRICAL ENGINEERING

FEBRUARY 1959
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Published monthly by American Institute of Electrical Engineers

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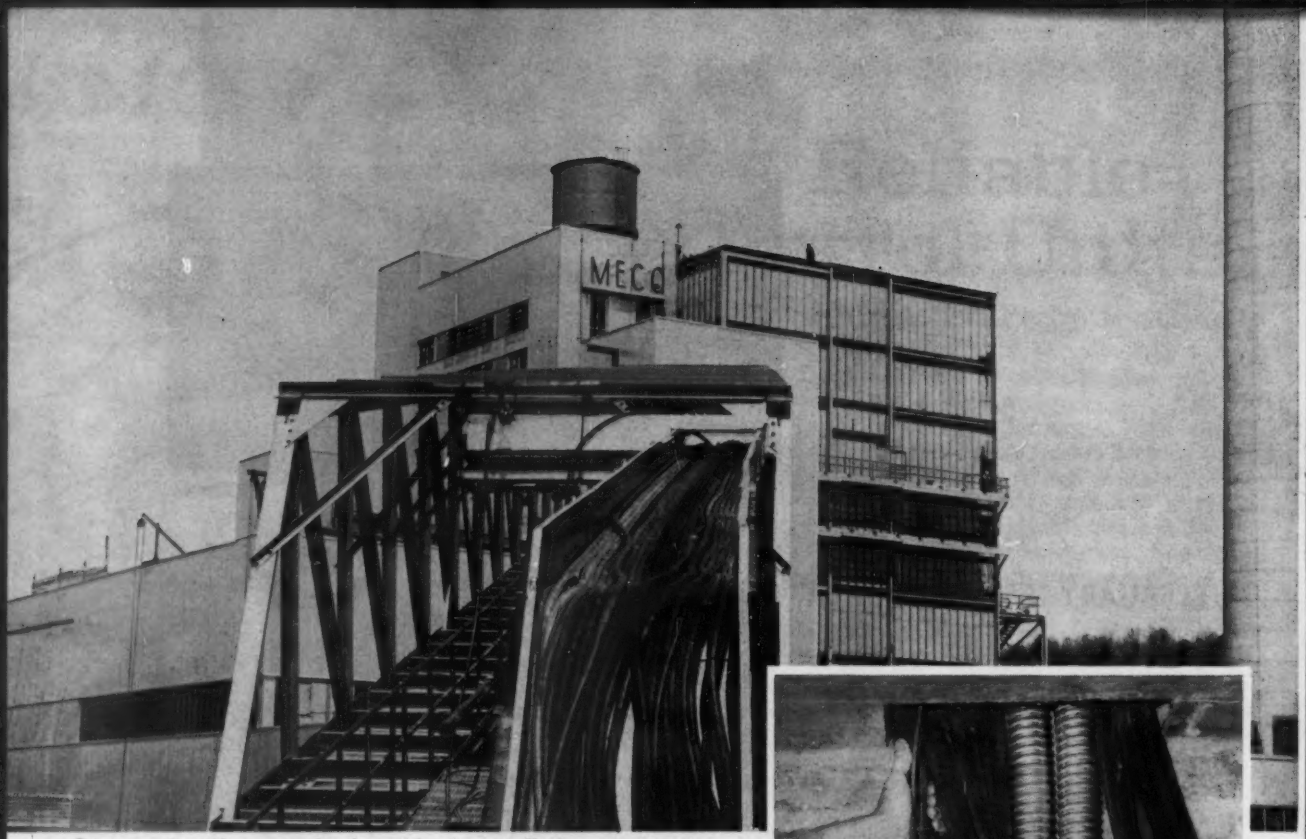

One construction, one basic cable design finds many uses. Open coal conveyor structure shown under construction above carries Okolite-Okoprene power and control cables from Metropolitan Edison Company's new Portland Generating Station to coal storage yard. Three types of the same cable meet in the tunnel (right) beneath the switching station: Okolite-Okoprene with CM-OT finish; Okolite-Okoprene with aluminum Loxarmor; Okolite-Okoprene with straight Okoprene sheath.

Another leading utility picks Okolite-Okoprene for maximum margin of safety

Utmost reliability, proved by long-term service records, is the reason why Okolite-Okoprene was selected for the brand new Portland, Pa., Generating Station of the Metropolitan Edison Company—engineered by Gilbert Associates, Inc. Various Okolite-Okoprene cables have been installed for 600-volt power and control service with protective coverings designed for specific installation conditions. For example:

- **To avoid expense of conduit...permit quick addition of new circuits**...Okolite-Okoprene power cable with flexible aluminum Loxarmor, in trays, carries power to motors, pumps, coal conveyors, fans and practically all other operating equipment.

- **For maximum protection against soil corrosion, mechanical damage and insect attack**...Okolite-Okoprene control cable with Type CM-OT (corrugated bronze tape) finish is used for direct burial underground circuits to the switching station in the yard. Finish combines remarkable compressive strength with light weight and easy handling.

- **For great weathering strength and resistance to abrasion**... Okolite-Okoprene control cable with an overall Okoprene sheath is used for most other control circuits within station ...and installed in outdoor trays leading to coal storage yard.

Power stations from coast to coast rely on Okolite-Okoprene for vital power and control circuits—a testimonial to its dependability . . . its long life and dielectric strength . . . its resistance to corona cutting, moisture, heat, chemicals and mechanical damage. For further information on this premium quality cable, made by Okonite's exclusive strip-insulating process . . . and its adaptability to your important circuits, write for Bulletin EG-1085, The Okonite Company, Passaic, New Jersey.

***where there's electrical power... there's* OKONITE CABLE**

6358

For more information circle 1 on reader service card.

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These S&C Cutouts reduce by shortening the arc,

As any lineman who has closed a cutout on a heavy fault knows, there's a violent blast of flame and "shrapnel." There are three ways to cut down this hazard:

1. Reduce the amount of fuse tube liner (fibre) exposed to the arc.
2. Reduce the energy of the arc.
3. Increase the bore diameter* to reduce the "muzzle velocity."

In S&C's Cutouts having interrupting ratings above 5000 amperes, all three methods are employed — together — making possible the exceptionally high interrupting ratings and at the same time reducing the violence of the blast.

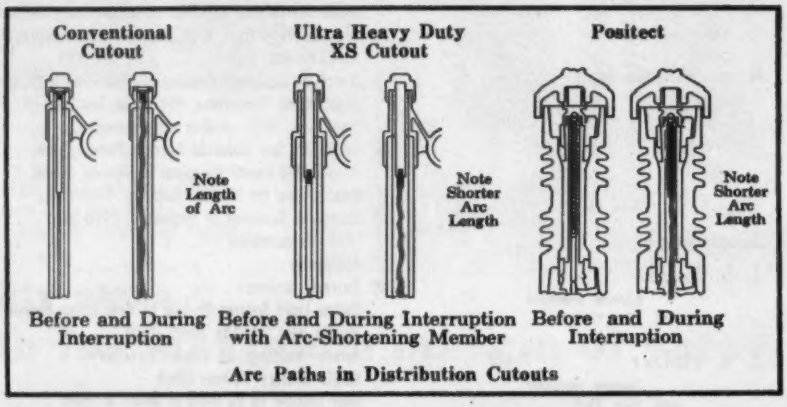
*This can be done without sacrifice of low fault interrupting capability by use of a fuse link made to interrupt low faults, in combination with a high speed terminal-separating device. In the Positect, this latter is a spring and cable assembly; in the XS, a spring-actuated cable flipper.

Here's how it's done:

The length of the arc is deliberately reduced by the use of an arc-shortening member. In the XS Cutout, this member is a husky copper rod; in the Positect, the member is a spring-and-cable assembly.

When the arc length is reduced, the arc voltage is reduced, and in turn the energy in the arc is reduced. At the same time, the arc has less fibre to act upon, and hence less gas is generated. Finally, with a somewhat larger bore in which to expand, the gases are not as violently accelerated out of the cutout's open end.

The result: less energy, less flame; less violence, and less hazard. And while such performance is of special importance at the highest fault levels, this same reduction applies proportionately across the entire range of faults.



Arc Paths in Distribution Cutouts

For voltages up to 14.4 kv

XS CUTOUTS

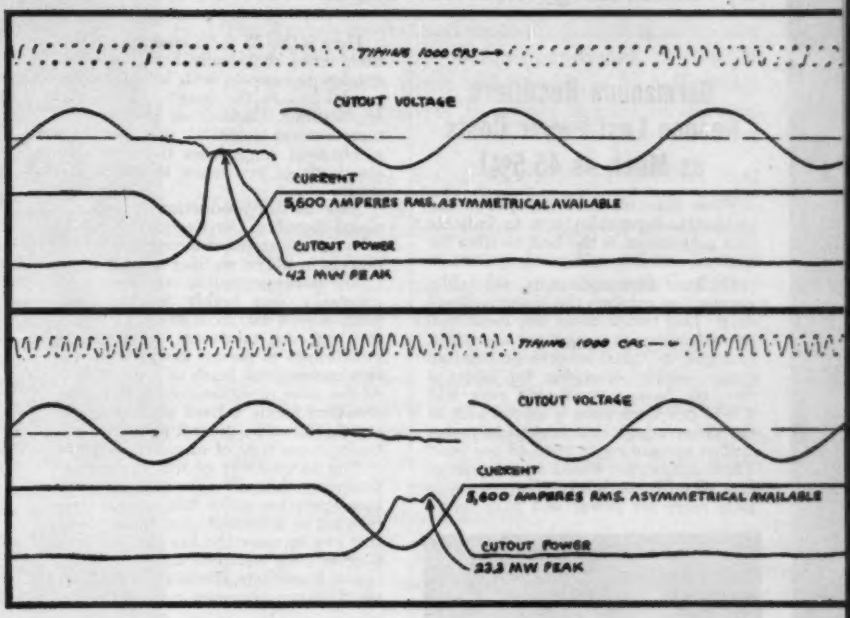
Open cutouts designed for use with LOADBUSTER®

This open cutout is designed for use on modern distribution systems to provide for the two performance factors of most concern: reliable interruption of the heaviest faults with minimum violence and to provide repetitive load switching capability. Available in Extra Heavy Duty and Ultra Heavy Duty styles with arc-shortening rod at 7.2 kv and 14.4 kv. (Also Heavy Duty styles at 7.2 kv, 14.4 kv, 25 kv, and 34.5 kv.) The XS Cutout can switch full rated loads up to 200 amperes with disconnect blade at 14.4 kv when used with LOADBUSTER, the portable loadbreak tool.

exhaust blast reducing the energy

Here's the proof:

This pair of oscillograms shows how "arc-shortening" reduces the arc energy. The upper oscillogram is taken from a test on an XS Cutout *without* an arc-shortening rod; the lower is *with* an arc-shortening rod. Note that the peak power—a measure of blast violence—is virtually cut in half, from 42 megawatts without the arc-shortening rod to 23.3 megawatts with the rod. But the available fault current being handled by the arc-shortening rod is exactly the same, 5600 amps rms asymmetrical. Note also that the maximum arc voltage has been reduced 50%. This is indirectly a measure of the reduced power in the arc.



For additional information: S&C Electric Company, 4427 Ravenswood Ave., Chicago 40, Ill. In Canada: S&C Electric Canada, Ltd., 8 Vansco Road, Toronto 14, Ontario.

S&C

For voltages through 4.8 kv

POSITECT CUTOUTS

Enclosed cutouts with full load switching capability

The S&C Positect is the only enclosed cutout with full load switching capability, without external arc or exposed hot parts. Will switch up to 300 amperes with disconnect tube. Note interrupter attachment which permits full load switching. Designed and tested for closing against faults. In case of fault closing, all blast is directed away from operator.

Specialists in High-Voltage Circuit Interruption Since 1910

INTERNATIONAL RECTIFIER CORPORATION

RECTIFIER NEWS

Advanced Ceramic Design of 25 Amp Silicon Diode Increases Reliability By Localizing Internal Expansion Under Shock Loads of Temperature

Here is the 25 to 45 amp silicon rectifier series that really has the "give" it takes to operate with long-term dependability in the toughest industrial applications. Capable of operation in temperatures to 200°C, they feature a mechanical ruggedness that sets new standards of resistance to shock and strain.

Now in full production at International Rectifier Corporation, these diodes are the result of a completely new process in silicon rectifier manufacture.

The package itself is extremely rigid externally, but highly flexible internally. Radial and axial stresses crossing the unit are taken up by adjoining membranes to permit localized expansion under shock loads of temperature. At the same time, the unique case construction forms a hard shell over the rectifier junction, protecting it from virtually every type of mechanical strain.

The adaptability of this new device to dc power supplies for high temperature operation make this a major step forward in semiconductor manufacture that can increase the life and performance of your equipment.

For immediate attention to your application requirements, contact the factory or our nearest sales office. Bulletin SR-304-A, describing these diodes in technical detail is now available.

Rating: 50 to 500 volts PIV • 25 to 45 Amps.

CIRCLE READER SERVICE CARD NO. 4

★ ★ ★

Assembling Your Own Silicon Stacks?

Write on letterhead for technical article "Mounting Methods and Cooling Considerations—Silicon Stud Mounted Diodes." Ask for Rectifier News—RN858.

Germanium Rectifiers Reduce Lost Power Costs as Much as 45.5%!

Four years of field experience has yielded indisputable facts to indicate that germanium is the best rectifier for high-current low-voltage equipment.

Of the semiconductors available, germanium exhibits the lowest voltage drop. This factor alone can mean real power savings to equipment users. For example, a 10,000 ampere germanium power supply operating ten hours a day, six days a week will save 912 KWH per week over a silicon unit of the same rating . . . a savings in power dollars amounting to $948.48 per year! These figures are based on an average cost of $.02 per KWH. The user who pays more for power will save more!

Pictured here is the International Rectifier 500 Ampere Germanium Junction featuring efficiency to 98.9% . . . the most efficient rectifier available for plating and other electrochemical applications from 1,000 to 200,000 amps. Write for Bulletin GPR-2S or . . .

CIRCLE READER SERVICE CARD NO. 3

Technical Article Available:

Elimination of Surge Voltage Breakdowns of Semiconductor Diodes in Rectifier Units.

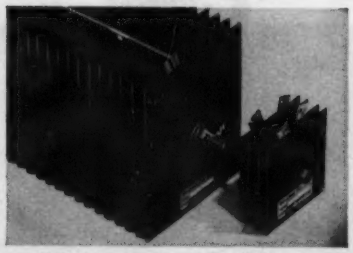
Write on your letterhead.

New Developments Broaden the Application Range of the Toughest of Rectifiers . . . Selenium!

Engineers who really know will tell you that the selenium stack is a veritable "brute for punishment!" Over the years it has proven to be the most dependable and versatile rectifier for the greatest number of power applications. Progressive developments at International Rectifier have resulted in cell types with distinct advantages to equipment where selenium has consistently proven best and have also opened new areas of application where it will excel.

52 VOLT CELLS reduce stack size 50% as compared to standard cells, and by reducing the number of cells, reduces forward resistance by 50%, making improvements in the regulation of power supply voltage possible.

HIGH CURRENT CELLS now deliver twice the rectified dc output per sq. in. than do the standard cells . . . again reducing stack size by 50%. High inverse voltage ratings and low forward drop are additional advantages.



Only International Stacks have the three features that add up to dependability: Fine Grain Selenium Layer, Platelok Construction and the Patented Bellows Spring.

If you design battery chargers, arc welders or mag amp equipment, look into these advancements. Write direct for Bulletins SR-152 and SR-160 or, if you prefer . . .

CIRCLE READER SERVICE CARD NO. 5

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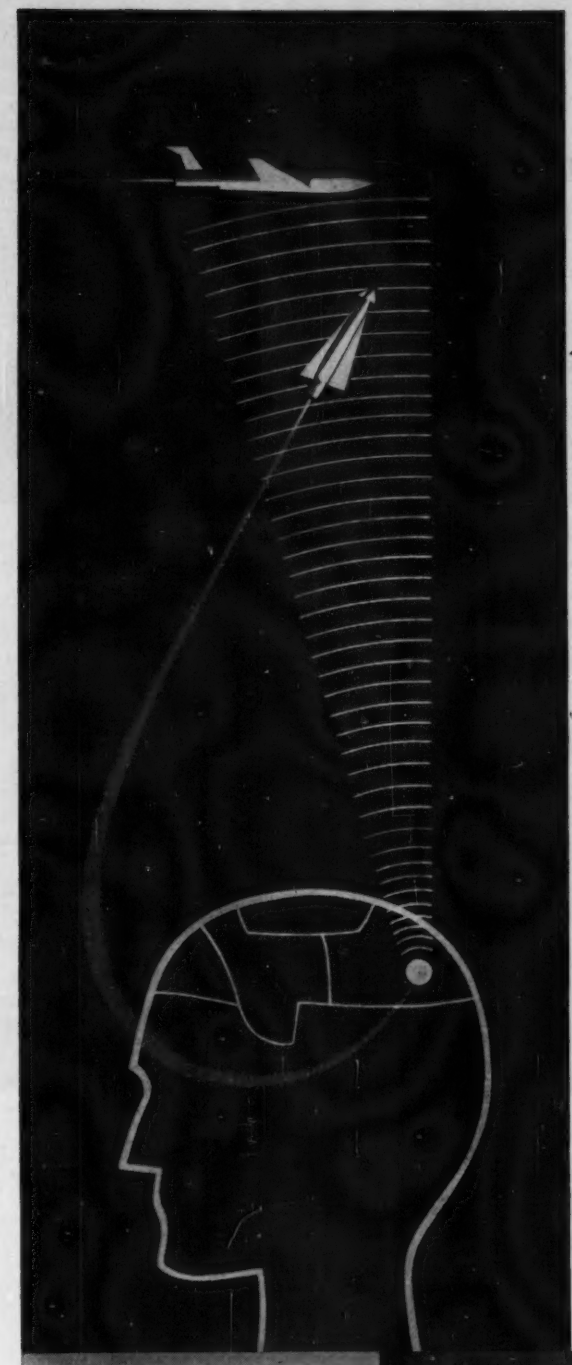


From Bell Telephone Laboratories...

Brainpower

for the brawny

Nike-Hercules

The Army's newest surface-to-air guided missile—the lethal Nike-Hercules—is now operational. Because it is, no unfriendly plane will be able to fly sufficiently high, fast or evasively to escape a fatal rendezvous with it.

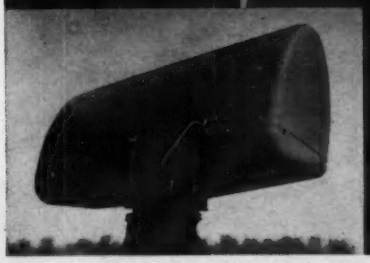
For Hercules has a "brain"—an intellect that makes it a prodigy among today's electronic robots. Bell Telephone Laboratories developed it. Western Electric (prime contractor for the entire missile system) is producing it. Douglas Aircraft Company is giving it its body.

This "brain" is a fully integrated guidance system, almost entirely land-based. Only the vital signal-receiving apparatus is expendable within the missile itself. Other highly practical features: it defies "jamming," is completely mobile, is designed in separate "building block" units which are replaceable in seconds—and is deadly accurate.

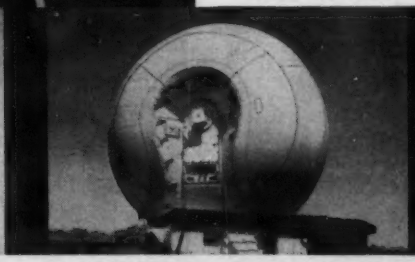
Bell Labs scientists and engineers designed the world's largest and most intricate telephone communications network for the Bell System. They developed about half of the Armed Forces' radar equipment during World War II. And they pioneered the nation's *first* successful air defense guided missile system—Nike-Ajax.

They were eminently qualified to give Hercules the brainpower it needed.

BELL TELEPHONE LABORATORIES
World center of communications research and development



Vigilant acquisition radar for Nike-Hercules first detects approach of distant aircraft, pinpoints its location and instantly signals to battery control.



Two tracking-radar antennas, housed in radomes, take over. One feeds target azimuth, elevation, range data to computers; other tracks Hercules.

Two sets of radar data are electronically computed and plotted. Hercules is "steered" by radio signals, then detonated at precise point of interception.

There Is No Magic Formula for Producing Substations, as Southern States Has Found from 910 Installations

As much as we like the idea of standardization, the one thing we have learned is that there is no cut-and-dried, assembly-line, easy way to produce substations.

We've been at it 28 years, producing more than 900 substations of all kinds, and it has always been tough for us!

Even stations with essentially the same assignments have endless arrangements. Infinite combinations of design preclude standardization. Each station must be virtually a custom-made project.

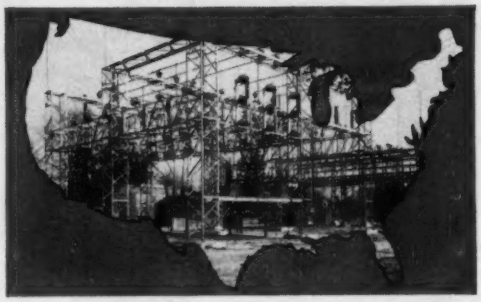
True, hundreds of designs in our files are helpful. Many standard components are picked up and used, with ultimate savings to our customers. And the practical experience of our design staff guides us around many pitfalls.

But you can't escape the fact that supplying substations requires these basic functions: skillful engineering, careful detailing, precise coordination of production schedules, and delivery on time. At least, that's what we've learned. And that's how Southern States approaches every substation assignment.

On this basis, you might like to do business with us. We'll welcome your inquiry. Just call your Southern States representative or write direct to us.

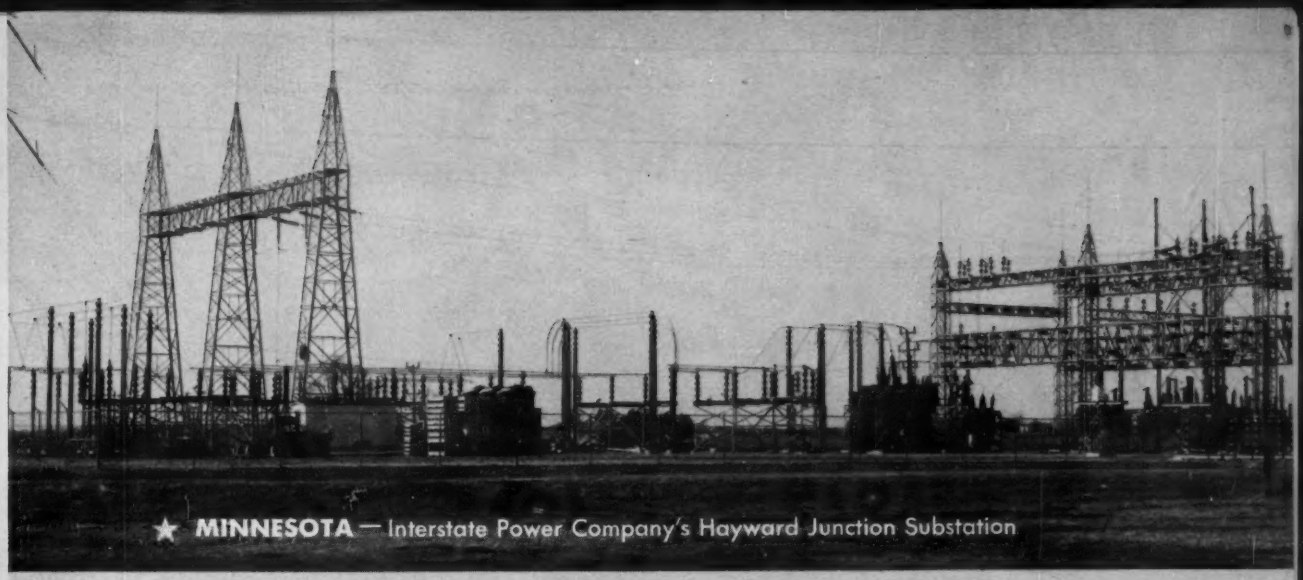
SOUTHERN STATES SUBSTATIONS ARE IN USE ALL OVER THE NATION

During the past 28 years Southern States has produced 910 outdoor substations for hundreds of different customers. The stations range from small 5,000 kva units to switchyards exceeding 1,000,000 kva. Regardless of size, Southern States pays close attention to every detail—from the single-line wiring diagram to the finished station.



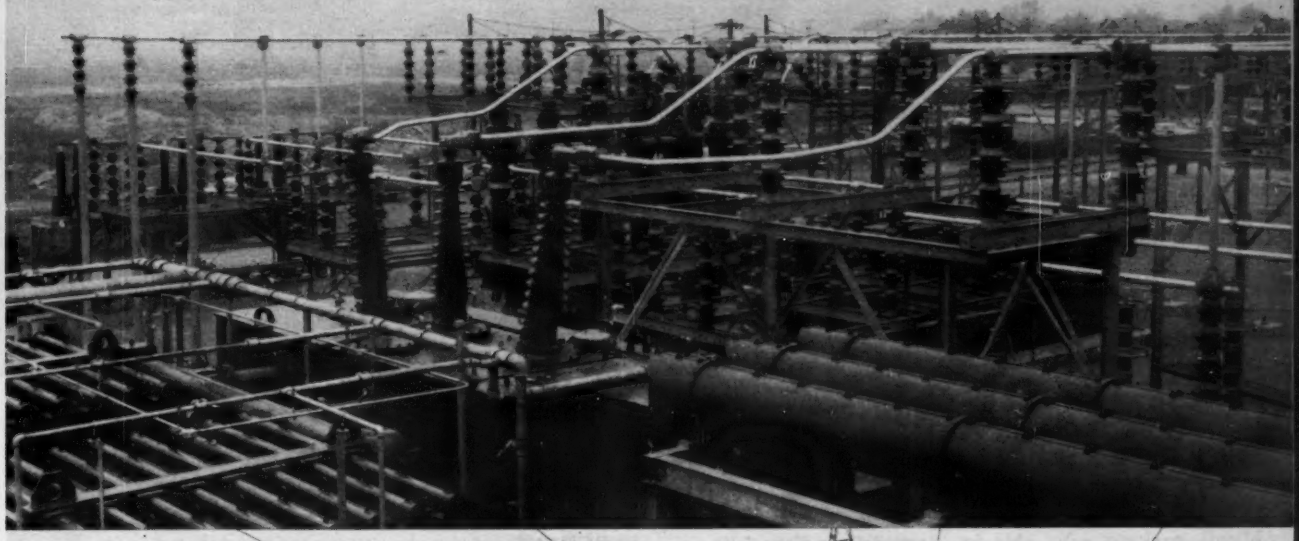
SOUTHERN STATES EQUIPMENT CORP.
HAMPTON, GEORGIA

IN CANADA: Dominion Cutout Co., Ltd., Toronto

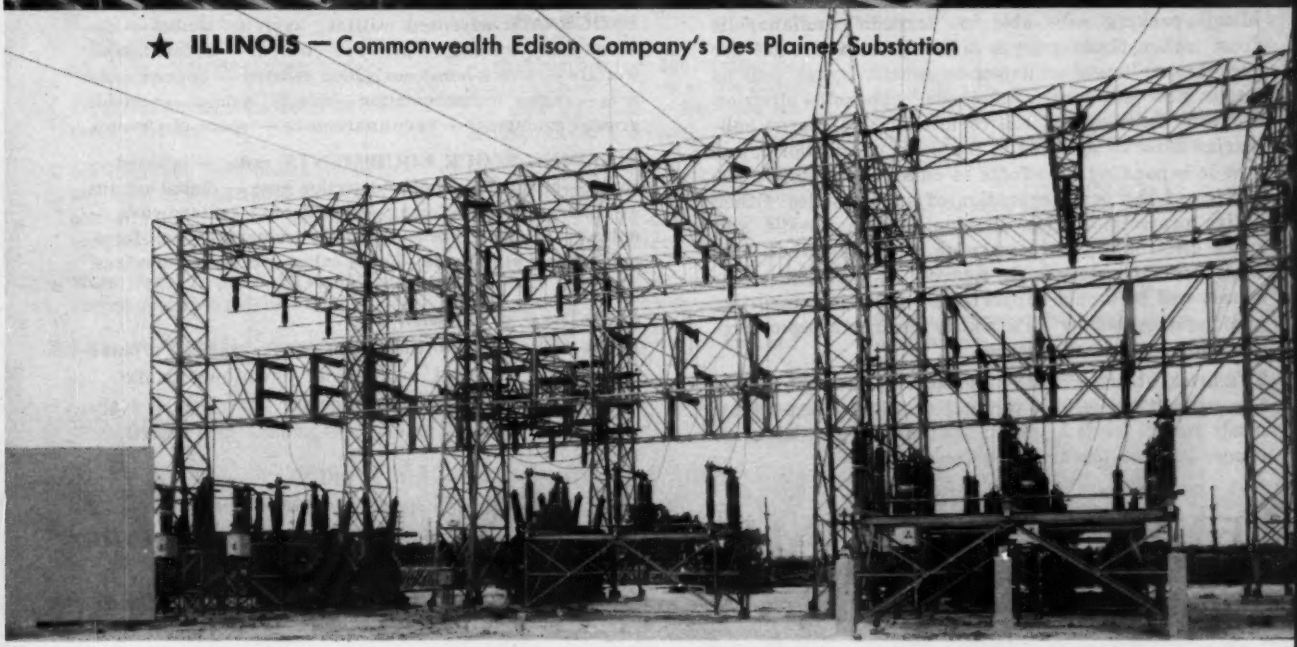


★ **MINNESOTA** — Interstate Power Company's Hayward Junction Substation

★ **NEW YORK** — Consolidated Edison's Corona Substation



★ **ILLINOIS** — Commonwealth Edison Company's Des Plaines Substation



In each of these substations Southern States worked closely with the utility, designing and detailing the structures; and supplying many components, including structural steel, air break switches, disconnects, buses, cable conductors, connectors, and bus supports.

In this age of missile-carrying submarines, our once protective oceans are now avenues for enemy attack.

circuit development — system planning engineers...

help nab hit-and-run divers

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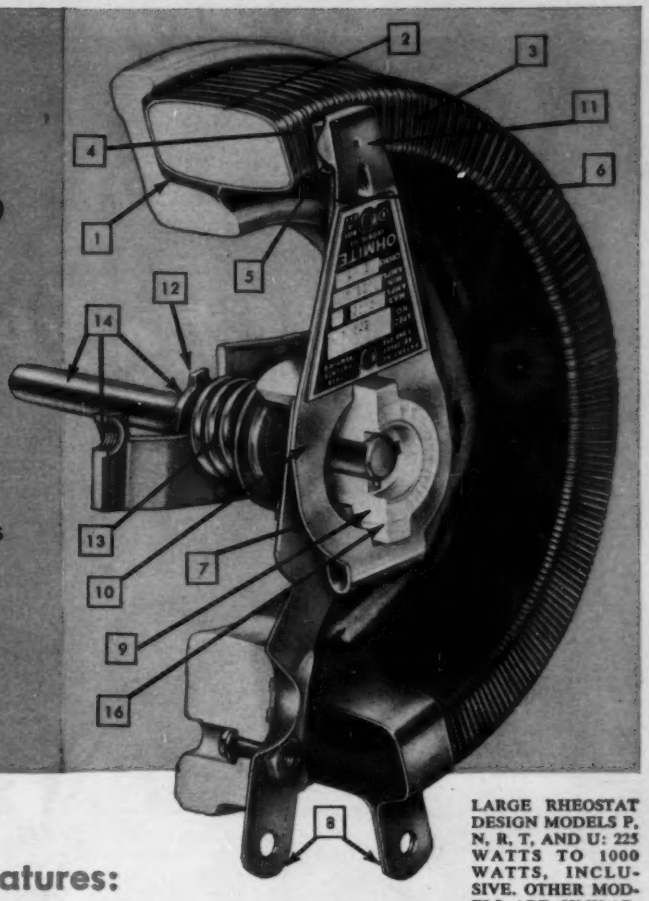

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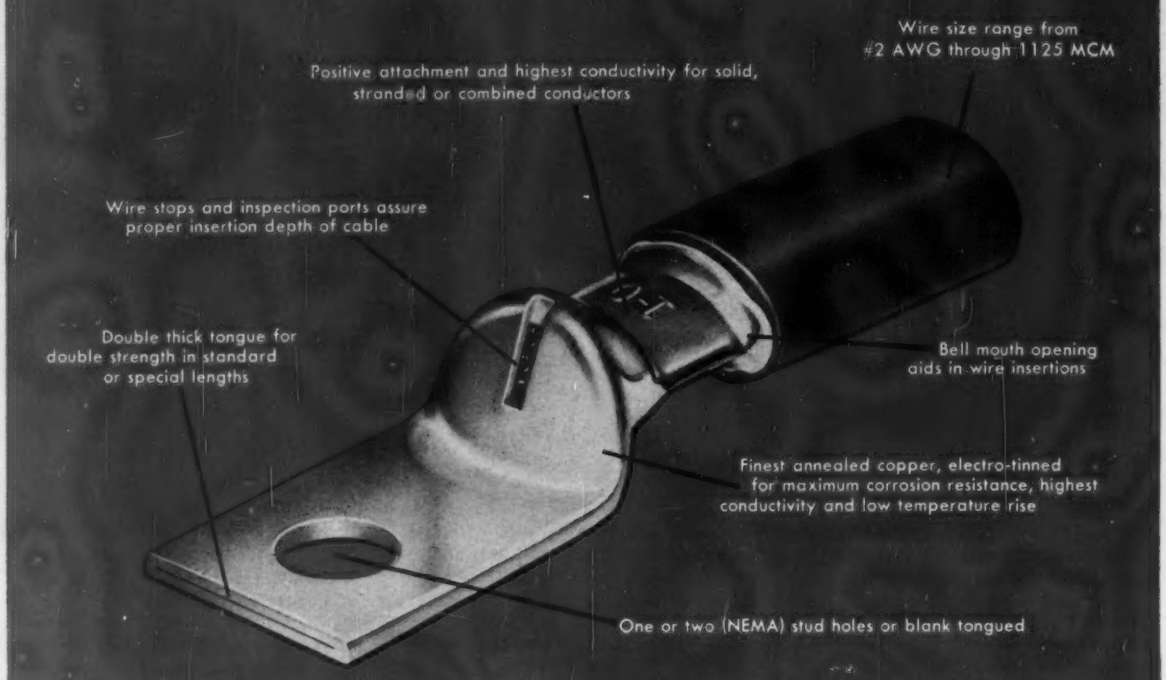
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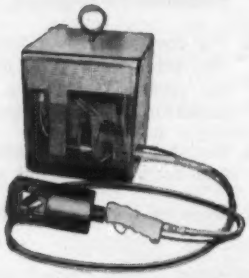

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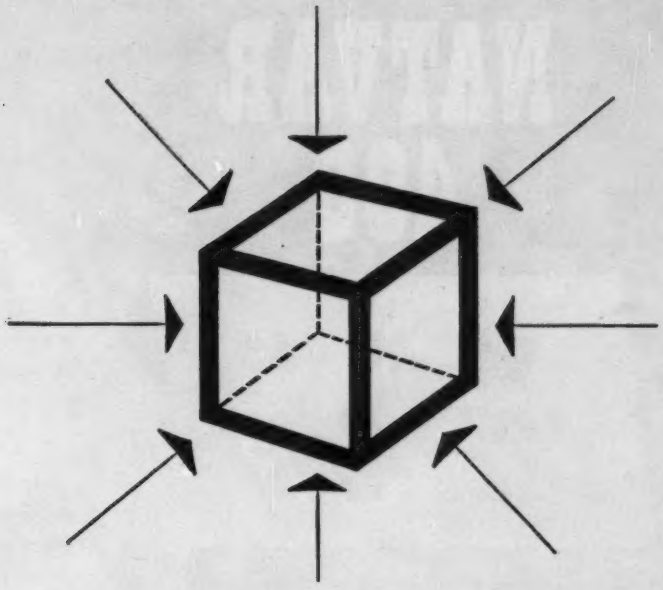

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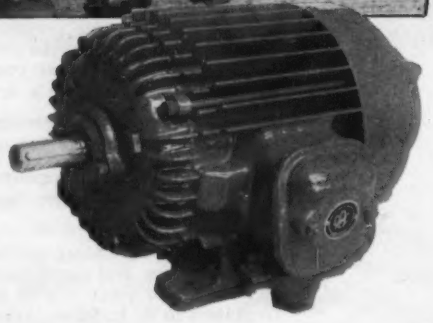

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A.C.E.C. (Ireland) Ltd. manufactures electrical apparatus in a modern plant in Waterford, the city on the southern coast where skilled craftsmen have been making the world-famous Waterford glass since the early nineteenth century.

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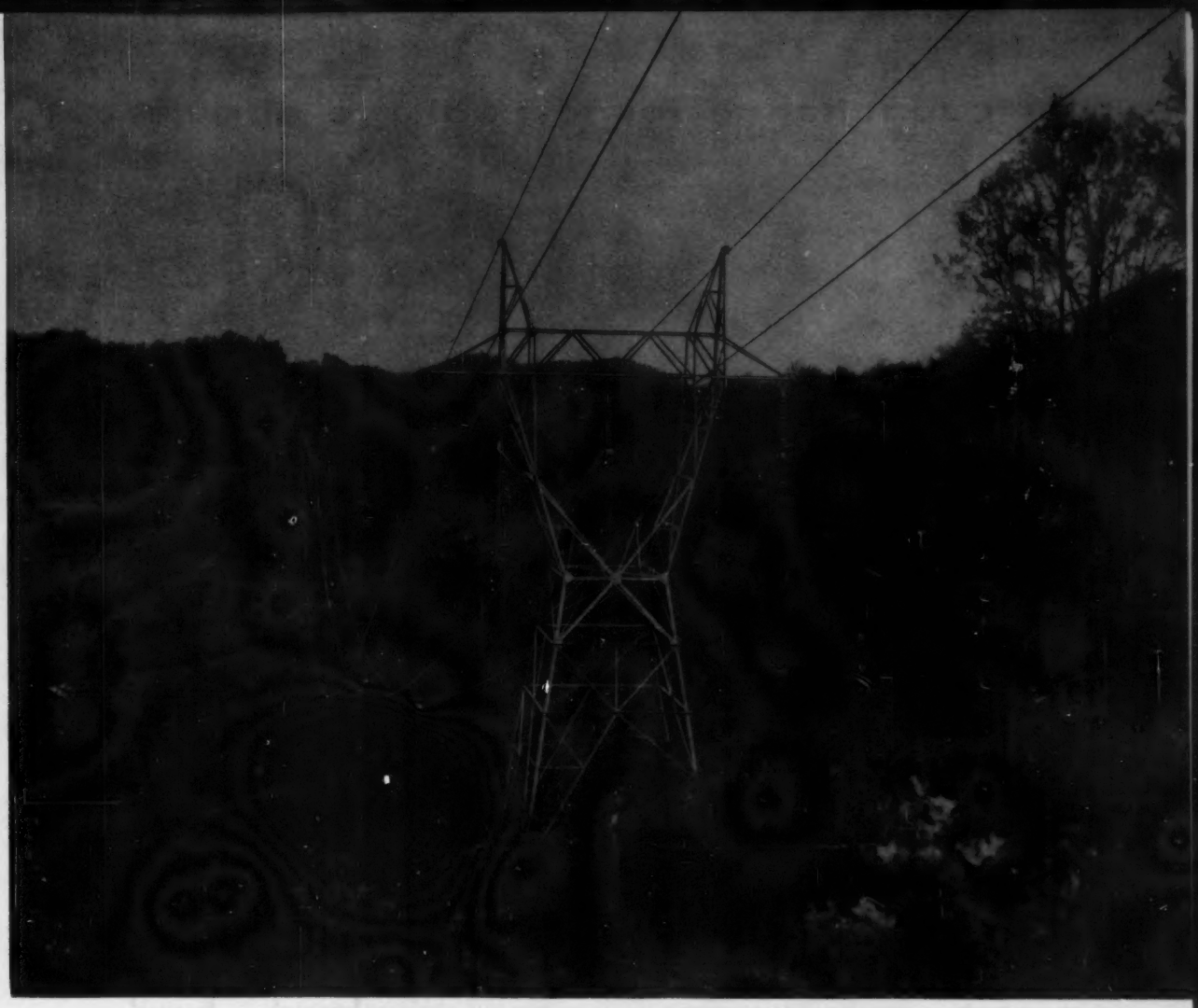

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Kentucky Utilities Company, a customer since 1918, recently bought 208 more American Bridge towers for its new Richmond-Lynch 138-kv line. Running through rugged mountainous area, these towers vary from 60 to 75 feet in height. *The longest span is 3,345 feet.*

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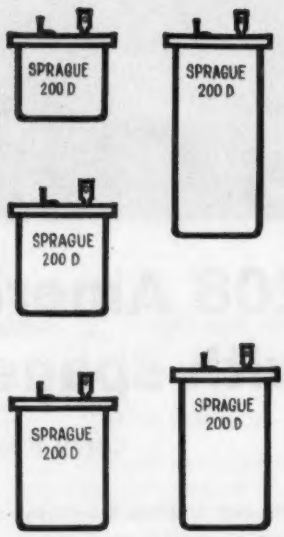

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A Salute to the American Institute of Electrical Engineers

It will be a notable event not only in the development of engineering but in our national history when the American Institute of Electrical Engineers celebrates its Seventy-fifth Anniversary.

That the Electrical Engineers have in this time added immense comforts and economic advancement of the American way of life needs no saying. But great honors are due the Institute for its promotion of the science and its guardianship of the ethics of the profession.

The Institute aside from its own accomplishments is one of the "Founding Fathers" of a multitude of other engineering societies which have grown with the years and advancing knowledge.

It has been a satisfaction to me over the years that I am enrolled among you as an honorary member.

Herbert Hoover

A I E E 75th Anniversary 1884 — 1959

75 Years—
A Prologue to the Future

Position on Organization of the Engineering Profession

A report prepared by the Intersociety Relations Committee of AIEE and approved by the Executive Committee. This report was presented to the Board of Directors of Engineers Joint Council (EJC) in response to a request to the constituent societies to prepare statements evaluating the work of EJC and suggesting areas for its future development.

THE BOARD OF DIRECTORS of AIEE, meeting in San Francisco, Calif., June 28 and 29, 1956, adopted a proposal regarding organization of the engineering profession of the United States which has since come to be known as the Functional Plan. Having spent some time sitting as a "Committee of the Whole" to discuss all aspects of the matter in detail, the Board reconvened to take the following actions:

1. Voted to adopt in principle, and actively to support, three organizations of a character approximating the present Engineers' Joint Council (EJC), Engineers' Council for Professional Development (ECPD), and National Society of Professional Engineers (NSPE) with certain functional modifications (as recommended by the Committee of the Whole) as currently most suitable to serve the over-all needs of the engineering profession.

2. Voted to request the President to appoint a special committee to draft, subject to Board approval, a statement to the members and other interested parties, setting forth the proposed AIEE position on intersociety relations as recommended by the Committee of the Whole.

3. Voted to request the President to appoint a committee with instructions to approach NSPE with the suggestion that its membership be opened, for a period of years, to nonregistered engineers holding suitable grades in technical societies subscribing to ECPD uniform membership grade standards.

4. Voted to rescind the instructions to AIEE representatives on the EJC Board of Directors to work for the development of EJC into an individual membership type of unity organization."

Action no. 4 related to long-standing instructions to AIEE representatives on the EJC Board of Directors to work for the development of EJC into an individual membership type of unity organization. Under the Functional Plan there would be no point in making EJC over in this way.

The functional modifications referred to in action no. 1 provided that EJC would relinquish its activities in the fields of employment conditions, labor legislation, practice of engineering, social security legislation, and certain kinds of surveys (the more recently initiated activity in engineering education would likewise be considered inappropriate); that ECPD would relinquish its interest in the practice of engineering; and that NSPE would relinquish its activities in the fields of technical education and young engineers.

Fig. 1 shows the Functional Plan.

EJC would function primarily as a co-ordinating body for technical matters crossing the boundaries of the various disciplines. It would retain its interest in the recognition of specialties, honors for engineers, National Engineers Register, and relations with corresponding bodies in foreign countries. It would continue functioning in such fields as national water policy and national transportation policy. It would function in an advisory capacity to the Federal Government in the engineering field in a manner similar to the functioning of the National Academy of Science in the scientific field. It should concern itself with the restoration abroad of respect for American engineering accomplishments, which we understand has recently suffered a decline. It would keep alert to the need for service to the engineering profession in newly developing fields of broad scope, such as nucleonics, and would take the initiative in arranging for such coverage by appropriate groups of its constituent societies, in order to prevent the formation of splinter groups. This is the "technical" group of activities.

ECPD would continue its interest in the education and development of young engineers, the establishment of standards for engineering education, the accreditation of engineering curricula, and the canons of ethics. This is the "educational" group of activities.

NSPE would continue its activities relating to registration of engineers and economic considerations in the employment of engineers, including salaries and fees. It would be responsible for promulgating rules of behavior in conformity with the ECPD canons of ethics and for legal enforcement of discipline under these rules. These rules would be formulated with the co-operation of ECPD. NSPE would be the spokesman for the profession in matters of legislation of interest to engineers at the national level, and its constituent state societies and local chapters would perform a similar function at the state and local levels. It would be responsible for public relations to enhance the social and economic

A report from the AIEE Intersociety Relations Committee, Elgin B. Robertson, chairman, W. J. Barrett, T. M. Linville. Report presented to the Board of Directors of EJC at its meeting of Nov. 21, 1958.

standing of the engineering profession as a whole. The other societies would, of course, be free to conduct such public relations activities as they consider appropriate in their own specific fields. The activities allocated to NSPE are those in the "professional" group.

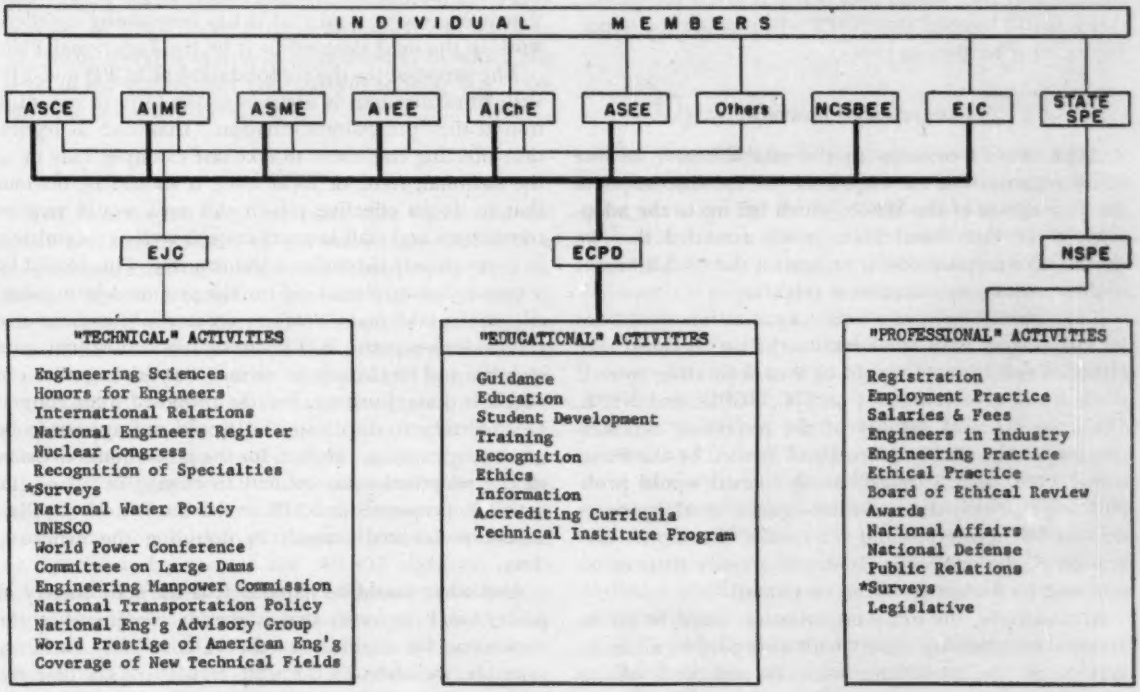
With regard to surveys of the profession, these would be the function of EJC when related to technical matters. When the subject to be surveyed is political or has to do with economic welfare and working conditions of engineers, it would be a responsibility of NSPE.

It is not contemplated under tne Functional Plan that AIEE would discontinue any of its interests or activities or any of the services which it customarily has been giving to its members, including students. Because of the variation in conditions affecting engineers in the various disciplines, it is contemplated that the Founder Societies and other similar groups will continue to maintain committees on such matters as education, registration, professional conduct, etc., for liaison with ECPD or NSPE, as the case may be, to insure that those groups are kept informed as to the particular viewpoints of the various disciplines.

REGISTRATION AND NSPE

IT IS CONTEMPLATED under this plan that the great majority of engineers would be affiliated with NSPE as well as with one or more of the societies which are constituents of EJC and ECPD. It will be noted that action no. 3 provided for a suggestion to be made to NSPE, without imposing this as a condition related to action no. 1. During subsequent meetings of the AIEE Board, it was decided that if NSPE would adopt this suggestion, AIEE would urge all of its members to affiliate with NSPE, whether registered or not.

AIEE has for many years recommended to its members that they take steps to register as professional engineers. We believe that this is an essential step in the full development of the engineer, whether he be a consultant or employed in Government or industry. We urge all young engineers to register in their states as early in their careers as possible. If this advice is heeded by members of all the Founder Societies, it is obvious that the time will come when the same people who make up those societies will be the members of NSPE, or at least eligible for membership in NSPE. It is believed that NSPE can put itself immediately in a much stronger position to carry out the responsibilities proposed for it by the Functional Plan if, for a period of years, it will open its membership to nonregistered engineers who are otherwise qualified as evidenced by their holding suitable grades of membership in those societies which subscribe to ECPD uniform membership grade standards. This is the reason for making this suggestion to NSPE as an interim measure and offering, if it is accepted, to urge all of our members, both registered and nonregistered, to join NSPE. NSPE already recommends that all



*EJC—When the subject is technical.
NSPE—When the subject is political, or economic welfare, or working conditions of engineers, etc.
NOTE: UET, Conference Board for Industry, AAAS continue to function as at present.

Fig. 1. Functional plan for the engineering profession.

of its members join their appropriate technical societies.

NSPE has not as yet adopted the AIEE suggestion with regard to membership at the national level. However, after analysis of the results of a questionnaire distributed to all of its state societies and local chapters, it took formal note of a considerable expression of opinion of its members in favor of considering the extension of membership in NSPE in any reasonable way to assist in the implementation of the Functional Plan, which it approved in principle. NSPE therefore decided not to change membership requirements at the national level "at this time" (June 1958) but recommended that the several state societies take such steps as may be necessary to admit properly qualified persons to membership. It should be noted that many of these state societies now admit nonregistered engineers, in some proportion, to membership.

Late in September 1958, AIEE sent out a questionnaire to its 13,905 Fellows and Members in the United States to find out how many were registered, how many of those were members of NSPE, and how many of the nonregistered would join NSPE if the discussed suggestion were accepted. Of the questionnaires, 71% were returned, but a surprisingly large number had to be discarded either for failure to answer completely or because of inconsistencies between the replies and the instructions. A total of some 7,400 replies were valid (53% of total mailed out). Of these, 63% stated that they were registered. Of those registered, 46% stated that they are members of NSPE. Of the nonregistered group, 71% indicated that they would join NSPE if given the chance. AIEE is still hopeful that NSPE will provide the opportunity for these men to join.

UNITY ORGANIZATION

AIEE IS NOT OPPOSED to the establishment of one unity organization for engineers. In the discussion of the Committee of the Whole which led up to the adoption of the Functional Plan, it was recorded that we should take no position for or against the establishment of such a unity organization at this time.

The establishment of a unity organization would not be inconsistent with the Functional Plan. It could take either of two forms. It could be a co-ordinating council made up of representatives of EJC, ECPD, and NSPE. Since the fields of activity of the respective organizations would be clearly defined and limited by the Functional Plan, such a co-ordinating council would probably serve principally to insure against overlapping or duplication of interests and as a symbol of complete unification of the profession. It should require little or no staff and its budget could be very small.

Alternatively, the unity organization could be an individual membership society with dues paid by all members of all the underlying societies and with officers elected by the direct vote of all those members. Such a unity organization would be stronger than a top coordinating council because of its large individual membership. With its officers and governing body elected by all the members directly, it would be in a position to speak with authority and would have the power to take action promptly on its own responsibility.

In declining to express itself for or against the establishment of an over-all unity organization in connection with the proposal of the Functional Plan, AIEE felt that a step of this kind should be deferred for a few years until experience has been gained with the operation of the Functional Plan as a guide to the proper type of unity organization, if one should then appear to be desirable.

MERGER OF ECPD AND EJC

THERE HAS BEEN considerable discussion recently of a proposal to consolidate ECPD with EJC and to set this up as the top unity organization with three "divisions" active in the technical, educational, and professional fields. It is proposed that NSPE become one of the constituent societies. Under this plan the present ECPD organization would presumably continue to function as the "educational division" of the proposed council type of unity organizations. The proposal makes no statement that NSPE would become the "professional division" of the organization. Some proponents of the plan have indicated that NSPE would probably be given responsibilities in this area gradually "as they demonstrated their ability to handle them." It is certain that NSPE cannot accept this. Recognition must be given to the fact that NSPE is one of the largest engineering societies, that it has been in existence for many years, that it is growing, and that it has been doing excellent work in the field assigned to it by the Functional Plan.

The proposal for the consolidation of ECPD and EJC with three divisions is silent as to the form of organization of the "professional division." Inasmuch as legislation affecting engineers, to take one example, may be at the national, state, or local level, it should be obvious that to do an effective job in this area would require committees and staff in every state as well as committees in every county throughout the country. This would be a tremendous undertaking for the proposed joint council, would take many years to accomplish, and involve tremendous expense. NSPE through its constituent state societies and local chapters already has this organization and it is doing business. For the proposed joint council to undertake to duplicate this would not appear to be good "engineering." In fact, for the professional division of the proposed joint council to engage in all of the activities proposed for NSPE under the Functional Plan would undoubtedly result in doubling the members' dues.

And what would be gained? It is the state society of professional engineers that is already recognized as the spokesman for engineers in the state. In New York, for example, members of the state legislature say that the engineers they can readily recognize, in the public view, are those who are registered and the only society they can look to is the state society of professional engineers. Legislation affecting engineers is referred to that society

and its disposition is practically decided by the attitude of the society. Conversations with O. D. Heck, Speaker of New York State Assembly, and others during January and February 1958 have confirmed this situation. The Governor also frequently takes counsel with the society's officers. This is the picture in other states as well. Does the suggested new joint council expect to be able to set up organizations in all the states and have these accepted by the state governments as the voice of the profession in place of the existing state societies? Or does it expect to have its voice heard in addition to, and perhaps sometimes in opposition to, the state societies? Or does it propose merely to claim the authority to represent the profession in this field and let NSPE continue to do the actual work?

As a matter of fact, AIEE is unable to see how this organization could be established with a "professional division" without duplicating the committees that already exist within NSPE. Thus, an impossible situation would be created for NSPE in which its functions would be taken over by the new organization. This would foster serious conflict and disunity. The new organization would be at a disadvantage because its financial income would be small compared to the dues income of NSPE. Also, its strength, influence, and activities in local communities would be comparatively small.

Moreover, ECPD stands now as a body reflecting credit and unity on the engineering profession, lending distinction and responsibility to its officers and chairmen, with its accreditation a cornerstone in the administration of many state registration regulations. There appears, to AIEE, to be little to be gained and much to be lost by merging it into an organization in which the seeds of incompatibility are inherent so long as a "professional division" is considered.

TAXATION

THE OPINION has been expressed that we should not allow tax classifications to govern in our choice of a form of organization, but that we should set up what we think is best to accomplish what we wish to do and let the chips fall where they may. Generally speaking, no one can take exception to this logic. At the present time, however, we should do nothing that might prejudice the tax classification that the Founder Societies and United Engineering Trustees (UET) now enjoy, especially since the Founder Societies are seeking $5 million from industry and $3 million from members as contributions to the cost of the proposed new United Engineering Center contending that such contributions are tax-deductible to the donor because of the 501 (c)3 classification of UET and the Founder Societies. Likewise, contributions and bequests are received from time to time by Engineering Societies Library and Engineering Foundation, which are departments of UET. This will continue indefinitely, we hope. The Board of Trustees of UET have applied for real estate tax exemption on the new building and have been told that this will depend upon the tax status of all the occupants of the building. Decision by the City of New York is being withheld at present. If real estate tax has to be paid on the new United Engineering Center, this will add materially to the costs of the Founder Societies.

EJC and ECPD are attempting at present to secure 501 (c)3 classifications. Their merger into a joint council with the three divisions contemplated might prevent getting such classification for either or both, and might react on the classification of the Founder Societies and UET.

Under the Functional Plan, there should be no question about EJC and ECPD getting a 501 (c)3 classification, although recent developments indicate that revision of the ECPD charter to describe its functions correctly would probably be necessary. The only society entitled to a 501 (c)6 classification under the Functional Plan would be NSPE, which already has that classification because of its avowed objectives, and which has its own headquarters in Washington, D. C.

RECOMMENDATION

AIEE APPEALS most urgently that no action be taken, such as is proposed, that we believe will disturb the compatibility that has existed in EJC, and ECPD.

It was in the spirit of fostering this compatibility that the Functional Plan was conceived by AIEE. A few years of trial of the Functional Plan would provide a background upon which to decide on the desirability and preferable type of unity organization.

Opto-Electronic Telescope

The heart of a new "opto-electronic" telescope, developed by the U. S. Air Force, is a new camera pick-up tube, perfected by the Westinghouse Electric Corporation. The tube is three to four times more sensitive to white light than tubes previously used for telescopes. Because it is particularly sensitive to longer wave lengths in the spectrum from yellow to red, the tube can produce daylight pictures of the moon and planets never before possible. It is now in operation at Wittenberg College in Springfield, Ohio.

R. K. H. Gebel, who conceived this opto-electronic system, and Lloyd Wylie, a professor of astronomy, have already used the telescope to produce a composite photograph of the full moon which is made up of more than 200 separate pictures. Forty inches in diameter, the composite picture shows details invisible to ordinary photography methods such as the rays of the crater Tycho.

The opto-electronic telescope operates essentially as a closed circuit television system. Images picked up through the telescope are transformed into electrical impulses by the camera tube, and are made visible on a cathode ray tube after passing through a video amplifier. Photos are then made from the picture tube.

Electrical Features of Indian Point Nuclear Electric Generating Station

T. D. REIMERS
FELLOW AIEE

A nuclear electric generating station, using a pressurized water type reactor, is under construction by the Consolidated Edison Company at a site about 24 miles north of New York City. The electrical features, particularly as they differ from those of a conventional plant, are described.

A NUCLEAR electric generating station is being built by the Consolidated Edison Company of New York on the Hudson River at Indian Point about 24 miles north of New York City. The reactor is of the pressurized water type, using a mixture of highly enriched uranium oxide and thorium oxide as a fuel. It will operate at 1,500 pounds per square inch, gauge (psig) and an average coolant temperature of 501 F. The primary coolant system consists of four parallel loops which circulate demineralized light water between the reactor vessel and the steam generators. Two canned motor pumps circulate the water in each loop.

Fig. 1. Aerial view, Indian Point nuclear station.

The steam generators produce steam at 449 F and 405 psig. This steam will pass through an oil-fired superheater to raise the temperature to 1,000 F and deliver 2,200,000 pounds of steam per hour to the turbine at this temperature and 355 psig. The turbogenerator is a tandem-compound 1,800-rpm condensing unit with an estimated gross operating capacity of 275,000 kw.

The reactor, steam generators, and primary circulating pumps are housed in a pressure-tight 160-foot-diameter steel sphere. To protect the public and personnel who will operate this unit and adjacent units in case of an accident in the sphere, an external radiation shield of concrete 3 to 6 feet thick surrounds the steel sphere. Fig. 1 is an aerial perspective sketch indicating the general arrangement of the completed plant. Fig. 2 is an elevation showing the location of the main plant components.

It has been our aim to make the design of the electrical features of this plant conform as closely as possible to that of our conventional plants. In most respects we have maintained these features. However, particularly for the nuclear portion of the plant, there are certain requirements at the present state of reactor development which necessitate modification of conventional electrical designs. This article deals particularly with these differences and the design modifications which result.

Reactor safety requirements suggest changes in the auxiliary power supply, control sources and controls, and instrumentation. To insure safe operation, considerable reactor instrumentation is duplicated and triplicated. Very little instrument duplication is provided in the conventional plant.

Radioactivity, humidity, and temperature in the sphere present an insulation problem. In addition, the large capacity of the generator with respect to a high-impedance tie through an adjacent company's system presents a stability and voltage regulation problem under certain operating conditions.

AUXILIARY POWER SUPPLY

FOR CONVENTIONAL unitized generating units we have been providing one start-up source from an adjacent substation for the unit auxiliary power bus and have transferred this bus to the generator as a supply source as soon as this unit was synchronized to the system. In the event of the unit being automatically cleared from the system by operation of protective relays or boiler–turbine–generator sequence trips, the supply to the auxiliary bus becomes de-energized. Under this condition, some lighting and a few small essential auxiliaries are automatically transferred to the start-up source.

In the reactor plant, it is desirable to maintain, at all times, a supply of power to as many as possible of the reactor's electrically driven auxiliaries. To prevent possible reactor core damage in a "scram" operation, it is

Full text of paper 58-1194, recommended by the AIEE Nucleonics and Power Generation Committees for presentation at the AIEE Fall General Meeting, Pittsburgh, Pa., Oct. 26-31, 1958.

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necessary to maintain service to at least one primary circulating pump, one seal make-up pump, one boiler feed pump, electrical control and instrumentation sources, other small essential equipment, and essential lighting.

To provide this reliability, the 13-kv auxiliary power bus has been designed in four sections. One bus is supplied from the generator terminals, two busses are each supplied by a feeder from different bus sections of an adjacent distribution substation, and the fourth bus is supplied through a step-down transformer from a 138-kv tie feeder to the neighboring Orange and Rockland Electric Company system. Fig. 3 is a one-line diagram of the main connections and the auxiliary system.

Normally, the four 13-kv auxiliary bus sections are operated with the bus tie breakers open. When the normal supply to a bus section becomes de-energized, that section may be tied manually to another section. No automatic transfer is provided for the 13-kv busses.

Each 13-kv light and power bus section has one feeder supplying load in the nuclear portion of the plant and one feeder supplying load in the conventional part of the plant.

These 13-kv feeders supply 937-, 1,250-, 2,000-, and 2,500-kva sealed dry-type transformers in load-center substations located close to the large auxiliary motors or load areas. Each 1,600-hp coolant pump motor is supplied from its own 2,300-volt grounded-Y load center. All other load centers supply 440 volts grounded Y except for two 125/216-volt grounded-Y units supplying lighting and small auxiliaries.

Automatic throwover from its normal load center source to a source fed from a different 13-kv bus section is provided for the following equipment:

1. One fresh water cooling pump and one river water cooling pump for the nuclear plant cooling requirements
2. Generator exciter motor–generator set
3. Valve motors
4. Essential turbine shutdown auxiliaries
5. One battery charger of each d-c control voltage system
6. Main turbine auxiliary oil pump
7. Fire pumps

Remote manual transfer is provided for the following equipment:

1. Spent-fuel cooling pump
2. Process transfer pump
3. Decay-heat cooling pump
4. Seal and make-up pump
5. Pressurizer heater group
6. Containment cooling fan
7. Control-rod hydraulic-pump motor

CONTROL AND INSTRUMENTATION SUPPLY

In the conventional plants, control power is supplied at 125 volts d-c from two busses, each having a battery and a rectifier or motor–generator set. Control centers are fed from both busses through interlocked automatic throwover switches. The 125-volt 60-cycle circuits for instrumentation are supplied from a bus fed from two 125/216-volt load centers through an interlocked automatic throwover switch.

In the nuclear plant, much of the reactor instrumentation requires an exceptionally reliable 125 volt a-c supply for electronic circuits used in monitoring reactor operation. Severe voltage dips or an interruption of even a cycle to this a-c instrumentation supply would cause scramming of the reactor.

To provide this reliable supply, 3-unit motor–generator sets have been specified, each having a normal drive motor supplied from one of the 440-volt 3-phase 60-cycle load centers, a d-c generator connected to a 125-volt d-c battery bus which acts as a motor when the normal a-c

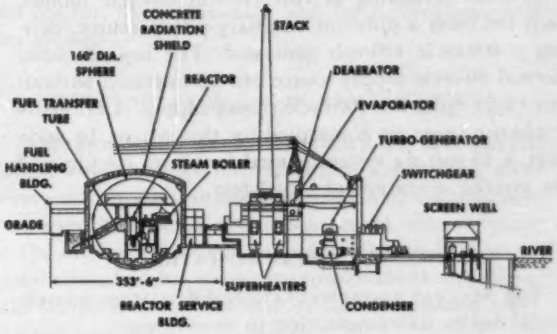

Fig. 2. Elevation, Indian Point station.

drive supply becomes de-energized, and a 125/216-volt 3-phase 60-cycle generator.

The connections of these sets are shown in Fig. 4. Each of two of the sets normally supplies separate 125-volt d-c control and 125/216-volt 60-cycle instrument busses. The third set, which is supplied from an essential 440-volt bus, can be connected to either of the d-c control and a-c instrument busses through remote-operated selector switches.

Normally, these busses will be operated as shown in Fig. 4. The spare motor–generator set may be connected to either one of the d-c control busses *DC-1* or *DC-2* and the instrument supply busses *60-1* or *60-2*. The respective busses would be tied only in the extreme emergency when the spare set is the only one available.

Important 125-volt d-c control centers will have a supply from each of the two control busses connected to it through an interlocked automatic throwover. The momentary interruption occurring during this transfer does not affect the operation of any equipment connected to this system, since no normally energized equipment is supplied from this system.

Half of the nuclear instrument circuits requiring a reliable supply will be fed from each of the two 125-volt 60-cycle instrument busses. In the event that the normal a-c motor driving the associated a-c generator is de-energized, the set will continue to be driven from the

battery of the 125-volt d-c bus by means of the d-c generator now operating as a motor. In such instances, the battery can usually be relieved by connecting the spare motor–generator set to the affected busses. In the extreme condition of losing the 440-volt supply to all the motor–generator sets, the reactor will have been scrammed by the safety protective system, and only a few instruments will have to be kept in service to monitor the conditions in the reactor core. By manually switching off all other circuits, the essential monitoring equipment can be operated by one of the a-c generators driven from the battery for at least 24 hours.

The reactor rod control system requires a 400-cycle power supply for magnetic amplifiers. This supply must also be exceptionally reliable, because its loss for only 5 milliseconds will cause the reactor to scram. This supply is obtained from a 3-unit motor–generator set with a flywheel consisting of two 440-volt 60-cycle motors, each fed from a different auxiliary power source, driving a 400-cycle 120-volt generator. The loss of either normal 60-cycle supply source can be tolerated without any effect upon the 400-cycle power supply. A normally shutdown spare set is installed for this system. In addition, a 48-volt d-c system is used for alarm circuits and for remote operation of switchgear.

NUCLEAR INSTRUMENTATION

THE NUCLEAR INSTRUMENTATION differs from conventional boiler instrumentation in several ways:

1. The primary variable is neutron density in the reactor, as compared with fuel firing rate in a conventional boiler.

2. The range of the variable is from 10^{-9}% to 150% of power level, as compared with 1% to 100% for a boiler furnace.

3. The nature of the variable displayed and recorded is "log power level" and "linear power" as compared to temperature, steam flow, etc.

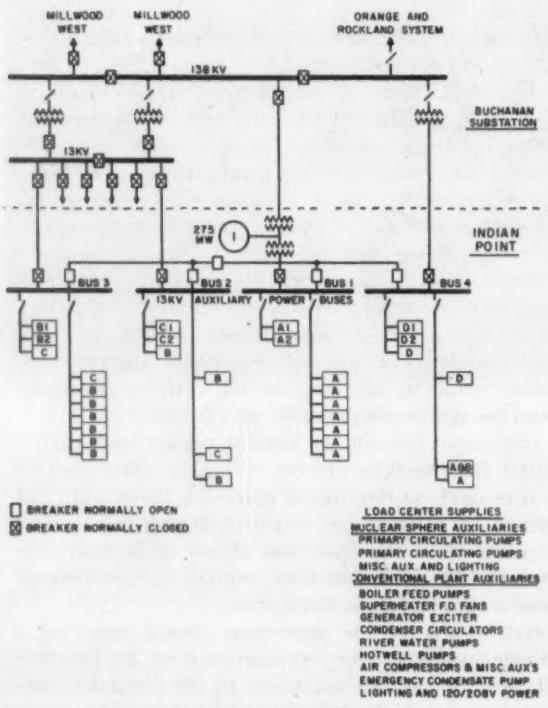

Fig. 3. Main connections and auxiliary power supply.

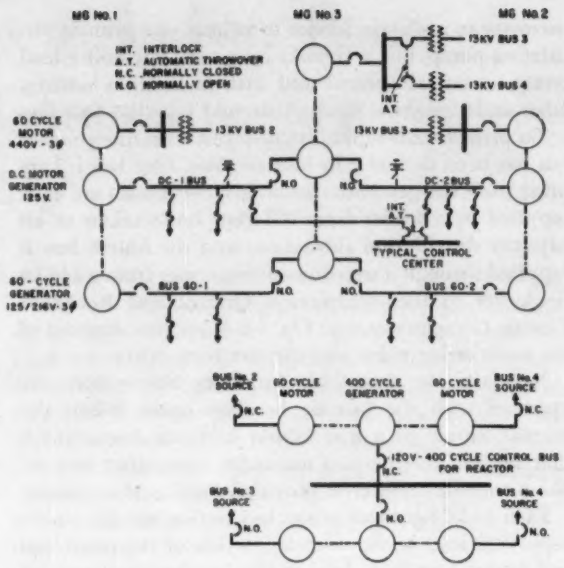

Fig. 4. D-c control for 60-cycle instrumentation and 400-cycle control systems.

Another important distinction is that the nuclear instrumentation provides the information required for control and for the safety system, whereas on conventional furnaces the control and safety systems are entirely separate.

The proposed nuclear instrumentation (Fig. 5) will provide 10 separate channels of information. These 10 channels divide into two groups, distinguished by their operating range. The first four channels are strictly start-up ranges covering the power level from start-up neutron source (10^{-9}%) to 0.1% of full load.

The other six channels overlap the upper end of the start-up range of power level and extend to 150% of full power. These are divided into two groups of which three channels provide log level and period* information from 10^{-3}% to 100%, while the other three channels display linear power level from 0.1% to 150%.

There is intentional duplication and 2-decade overlapping because of the extreme importance of this instrumentation to both the operators and the safety system. Thus, channel 2 duplicates channel 1, both operating from neutron counters and providing indication of log count rate and period, which operate indicating instruments and recorders and, through an "auction-

* The term "period" is a measure of the time in seconds for the power to change by the factor ε (= 2.718).

eering" device for log count rate and period, provide a signal from the higher of the two channels for optional use in the safety system. The auctioneering device is an electronic device which chooses the higher (or lower) of two signals and passes on the chosen signal.

Similarly, channel 4 duplicates channel 3, both providing log count rate and period information in the range of 10^{-6}% to 0.1% of full power. Auctioneering is used as in channels 1 and 2, and signals of count rate and period are available for optional use in the safety system. These channels also supply indicating instruments and recorders.

Channels 5, 6, and 7 are triplicates. They measure log power level and period in the range from 10^{-3}% to 100%, supplying indicating instruments and recorders and providing a signal to the safety system from each channel. These safety system signals are "fail safe" in that zero signal denotes a hazardous condition. If one of the three channels delivers a zero signal, an alarm indication is initiated. A second zero signal from these three channels causes the safety system to scram the reactor.

Channels 8, 9, and 10 are also triplicates. They provide indicated and recorded information of linear power level in 0.1% to 150% of full load. In addition, they provide safety system signals with the same features as channels 5, 6, and 7. Furthermore, these channels furnish signals to the automatic control system and the flux-flow computer. This device computes the ratio of the reactor neutron-flux level to coolant flow and functions as a component of the reactor control system.

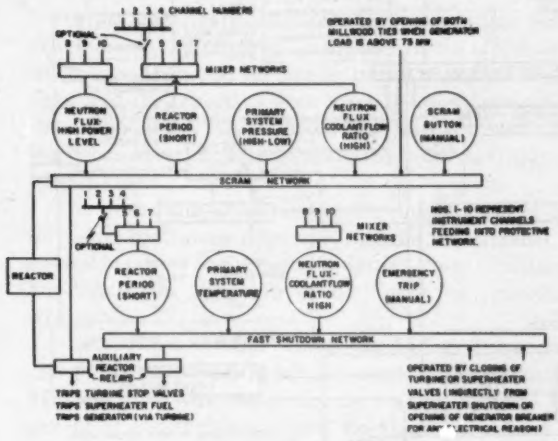
1 2 3 4 CHANNEL NUMBERS
OPTIONAL
8 9 10
5 6 7
MIXER NETWORKS
OPERATED BY OPENING OF BOTH MILLWOOD TIES WHEN GENERATOR LOAD IS ABOVE 75 MW
NEUTRON FLUX-HIGH POWER LEVEL
REACTOR PERIOD (SHORT)
PRIMARY SYSTEM PRESSURE (HIGH-LOW)
NEUTRON FLUX COOLANT FLOW RATIO (HIGH)
SCRAM BUTTON (MANUAL)
SCRAM NETWORK
1 2 3 4
5 6 7
OPTIONAL
8 9 10
MIXER NETWORKS
NOS. 1-10 REPRESENT INSTRUMENT CHANNELS FEEDING INTO PROTECTIVE NETWORK.
REACTOR
REACTOR PERIOD (SHORT)
PRIMARY SYSTEM TEMPERATURE
NEUTRON FLUX-COOLANT FLOW RATIO HIGH
EMERGENCY TRIP (MANUAL)
FAST SHUTDOWN NETWORK
AUXILIARY REACTOR RELAYS
TRIPS TURBINE STOP VALVES
TRIPS SUPERHEATER FUEL
TRIPS GENERATOR (VIA TURBINE)
OPERATED BY CLOSING OF TURBINE OR SUPERHEATER VALVES (INDIRECTLY FROM SUPERHEATER SHUTDOWN OR OPENING OF GENERATOR BREAKER FOR ANY ELECTRICAL REASON)

Fig. 5. Reactor protection

All of the reactor instrumentation involves neutron counters of various types, electronic amplifiers of the tube and magnetic designs with power supplies, auctioneering and averaging circuitry, etc., which is to be installed in enclosed, ventilated cubicles in groups such that a fire in any one cubicle will not affect more than one channel. Temperature of the atmosphere in each cubicle will be monitored.

Since 1953, Consolidated Edison has been using an integrated automatic trip protection system for turbine–generators and boilers, which was described previously.[1] This protection has proved very satisfactory in detecting undesirable conditions not immediately recognizable by the operator and in reducing the extent of damage. The system has been shown to be very reliable, and false tripping has been held to a minimum.[2]

In the instance of the nuclear plant, essentially the same automatic protection will be provided for the turbine and superheater as normally would be provided for the turbine and boiler. Fig. 5 shows the additional protection for the nuclear reactor and its interconnection with the superheater, turbine, and general protection. In Fig. 6, the over-all automatic protection of the reactor, the superheater, and the turbine-generator are shown.

INSULATION PROBLEMS IN REACTOR SPHERE

ELECTRICAL INSULATING MATERIALS in the nuclear sphere will be subjected to conditions considerably more severe than in conventional power plants. Ambient temperatures of 45 to 65 C are expected to exist normally in the nuclear sphere, as compared to 40 to 50 C in the conventional plant. Humidity conditions in the sphere will be more severe and may, at times, approach 100% relative humidity.

Electric equipment in the sphere will be normally subjected to radiation of 50 to 150 roentgens per hour, a problem which does not exist at all in conventional plants.

All power, control, and instrumentation cables entering the sphere must be so installed as to prevent leakage at operating pressures up to 25 psig which may occur during an accident in the reactor.

To minimize difficulties associated with electrical insulating materials under these more severe conditions, every effort has been made to place electric equipment outside the sphere. This will also aid in maintenance, inasmuch as the radiation level prohibits employees from entering the sphere under operating conditions. All major contactors, switches, and similar equipment are located outside both the sphere and concrete radiation shield. Limit switches and terminal boards which have to be located in the sphere are of glass base materials with silicone impregnants. Such devices generally will be in watertight housings. There are some 75 electric motors in the sphere, ranging from fractional to 1,600 hp.

All motors in the sphere will be totally enclosed and will have Class H insulation for maximum resistance to temperature and radiation effects. The primary circulating pump motors are of the "canned" type.

Motor circuits will be glass tape silicone rubber impregnated lead covered cable. The cable will be wiped to glands at the gasketed motor terminal box. Cables rated for 2,300 volts, such as those used for the 1,600-hp

coolant pump motors, as well as other large 440-volt cables, will be terminated at the sphere wall in solder seal potheads whose metal body is welded to the sphere wall with the porcelain section outside the sphere and with the lead sheath of the cable wiped to the pothead gland inside the sphere.

Small low-voltage power and control cables will be lead covered and will be brought into the sphere through wiping glands, as shown in Fig. 7. The several insulated conductors will be sealed in this sleeve with a suitable filling compound which hardens, fills in the spaces, and seals to both the individual conductor insulation and to the sleeve. Investigations and tests are now in progress to select the most suitable wire insulation material and filling compounds for this purpose and for withstanding the radiation and temperature effects.

Both the potheads and the smaller wiping sleeves which penetrate the sphere must hold the 25-psig pressure possible in the sphere in the event of a reactor accident. They will be designed for twice this pressure.

Outside the sphere, the cable insulation for 2,300- and 440-volt power cables and for control cables will be ozone-resisting compound rubber, as used in our present stations.

CONNECTION OF NUCLEAR GENERATOR TO SYSTEM

THE CONNECTIONS of the Indian Point nuclear electric generating plant to the Consolidated Edison and neighboring systems are shown in Fig. 8. The unit feeds at 138 kv into the new Buchanan substation located about ¾ mile from the generator. This substation has two 138-kv ties to Consolidated Edison's Millwood substation and one 138-kv tie connected to Orange and Rockland 69-kv system at Lovett generating station through a step-down autotransformer. Note that there is another tie loop from Lovett through the Orange and Rockland–Central Hudson–Niagara Mohawk systems back to Millwood substation.

The connection of this machine at a point on the systems having two large-capacity low-impedance ties on common towers in one direction and a single high-impedance tie through smaller systems in the other direction presents some operating problems should the Buchanan–Millwood lines become opened for any reason.

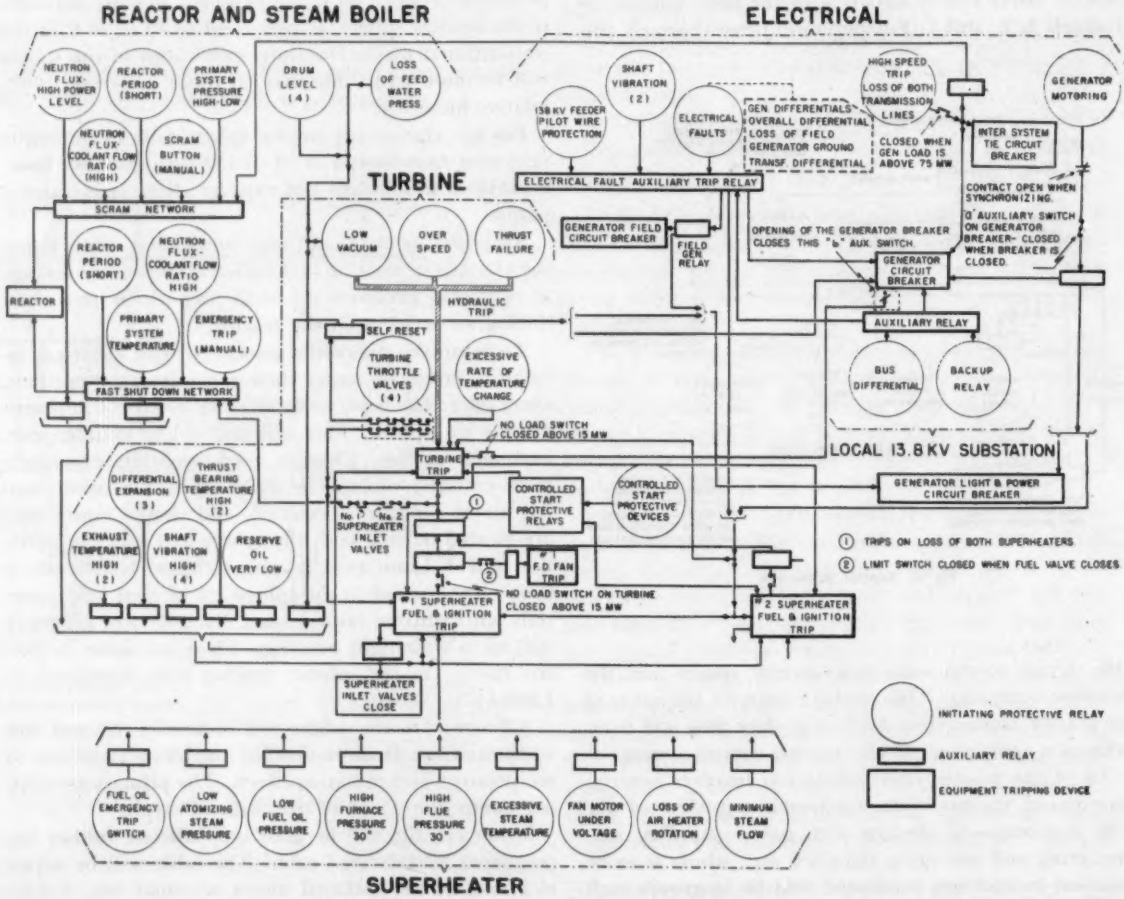
REACTOR AND STEAM BOILER
ELECTRICAL
NEUTRON FLUX-HIGH POWER LEVEL
REACTOR PERIOD (SHORT)
PRIMARY SYSTEM PRESSURE HIGH-LOW
DRUM LEVEL (4)
LOSS OF FEED WATER PRESS
NEUTRON FLUX-COOLANT FLOW RATIO (HIGH)
SCRAM BUTTON (MANUAL)
SCRAM NETWORK
REACTOR
REACTOR PERIOD (SHORT)
NEUTRON FLUX-COOLANT FLOW RATIO HIGH
PRIMARY SYSTEM TEMPERATURE
EMERGENCY TRIP (MANUAL)
FAST SHUT DOWN NETWORK
TURBINE
LOW VACUUM
OVER SPEED
THRUST FAILURE
HYDRAULIC TRIP
SELF RESET
TURBINE THROTTLE VALVES (4)
EXCESSIVE RATE OF TEMPERATURE CHANGE
NO LOAD SWITCH CLOSED ABOVE 15 MW
TURBINE TRIP
DIFFERENTIAL EXPANSION (3)
THRUST BEARING TEMPERATURE HIGH (2)
EXHAUST TEMPERATURE HIGH (2)
SHAFT VIBRATION HIGH (4)
RESERVE OIL VERY LOW
No 1 No 2 SUPERHEATER INLET VALVES
SUPERHEATER INLET VALVES CLOSE
SHAFT VIBRATION (2)
138 KV FEEDER PILOT WIRE PROTECTION
ELECTRICAL FAULTS
GEN. DIFFERENTIALS OVERALL DIFFERENTIAL LOSS OF FIELD GENERATOR GROUND TRANSF. DIFFERENTIAL
HIGH SPEED TRIP LOSS OF BOTH TRANSMISSION LINES
CLOSED WHEN GEN LOAD IS ABOVE 75 MW
GENERATOR MOTORING
INTER SYSTEM TIE CIRCUIT BREAKER
CONTACT OPEN WHEN SYNCHRONIZING.
"a" AUXILIARY SWITCH ON GENERATOR BREAKER- CLOSED WHEN BREAKER IS CLOSED.
ELECTRICAL FAULT AUXILIARY TRIP RELAY
GENERATOR FIELD CIRCUIT BREAKER
FIELD GEN. RELAY
OPENING OF THE GENERATOR BREAKER CLOSES THIS "b" AUX. SWITCH.
GENERATOR CIRCUIT BREAKER
AUXILIARY RELAY
BUS DIFFERENTIAL
BACKUP RELAY
LOCAL 13.8 KV SUBSTATION
GENERATOR LIGHT & POWER CIRCUIT BREAKER
CONTROLLED START PROTECTIVE RELAYS
CONTROLLED START PROTECTIVE DEVICES
F.D. FAN TRIP
NO LOAD SWITCH ON TURBINE CLOSED ABOVE 15 MW
#1 SUPERHEATER FUEL & IGNITION TRIP
#2 SUPERHEATER FUEL & IGNITION TRIP
① TRIPS ON LOSS OF BOTH SUPERHEATERS
② LIMIT SWITCH CLOSED WHEN FUEL VALVE CLOSES
FUEL OIL EMERGENCY TRIP SWITCH
LOW ATOMIZING STEAM PRESSURE
LOW FUEL OIL PRESSURE
HIGH FURNACE PRESSURE 30"
HIGH FLUE PRESSURE 30"
EXCESSIVE STEAM TEMPERATURE
FAN MOTOR UNDER VOLTAGE
LOSS OF AIR HEATER ROTATION
MINIMUM STEAM FLOW
SUPERHEATER
INITIATING PROTECTIVE RELAY
AUXILIARY RELAY
EQUIPMENT TRIPPING DEVICE

Fig. 6. Protection system for nuclear station.

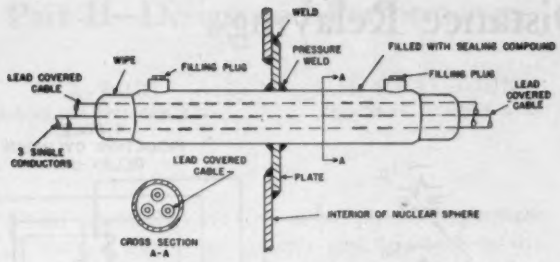

Fig. 7. Cable penetration through sphere.

Either of the Buchanan–Millwood lines alone is adequate for the transmission of the 275-mw capacity of this new nuclear-powered generator to the system. If both of these lines are out of service, only about 75 mw of the total output can be absorbed locally and transmitted satisfactorily through the high-impedance ties of the Orange and Rockland–Central Hudson–Niagara Mohawk systems.

Network analyzer studies indicate that the simultaneous trip-out of both Millwood lines with the nuclear unit carrying loads in excess of 150 mw would create a stability problem in the neighboring Orange and Rockland utilities system. These studies also indicated that it would be inadvisable to attempt to reclose these lines with the Indian Point generator, previously operating near its maximum capability, because of the very large resultant current surges.

Further investigation showed that if the Indian Point generator was also tripped on the occurrence of a double Buchanan–Millwood tie outage, under peak-load conditions and the outage of even a small Lovett generator, the neighboring system could not support both the Buchanan substation and the Indian Point auxiliary essential load.

The probability of obtaining the combination of the foregoing conditions is remote, but the requirement of a reliable supply to the essential Indian Point auxiliaries has led to the adoption of the following protective scheme:

Under any condition where the Indian Point generator output exceeds 75 mw, an opening of both of the Millwood ties will also scram the reactor and trip the generator and the Orange and Rockland tie breaker at Buchanan. This leaves the essential nuclear auxiliary load connected through a transformer on the feeder side of the Orange and Rockland tie circuit breaker, inasmuch as this feeder remains alive from the Orange and Rockland system. The Millwood tie, or ties, will automatically reclose if the fault has cleared. If one or both Millwood lines successfully reclose, the Orange and Rockland tie also will be permitted to reclose automatically.

Following this, it becomes necessary to restart the reactor, bring the turbine–generator up to speed, and resynchronize to the system.

In the event that the Millwood ties lock out on reclosure, the Orange and Rockland tie will not reclose automatically. The restoration of the Buchanan load, the ties, and the generator will then be performed manually as load and capacity conditions permit.

CONCLUSIONS

1. The electrical features of a nuclear-powered turbine–generator plant are similar in many respects to a conventional plant.

2. To protect the reactor from core damage, a more diversified auxiliary supply is required than for conventional plants.

3. Very reliable sources, unaffected by system disturbances, of 125-volt 60-cycle power for instrumentation and of 125-volt 400-cycle power for the safety and rod control systems are required for the nuclear plant.

4. Over-all reactor–superheater–turbine–generator automatic protection uses the same principles developed for the conventional plant with added information obtained from the reactor.

5. Location of this large unit at an interconnection point having large low-impedance ties to one system and small high-impedance ties through another system presents some unusual protection problems.

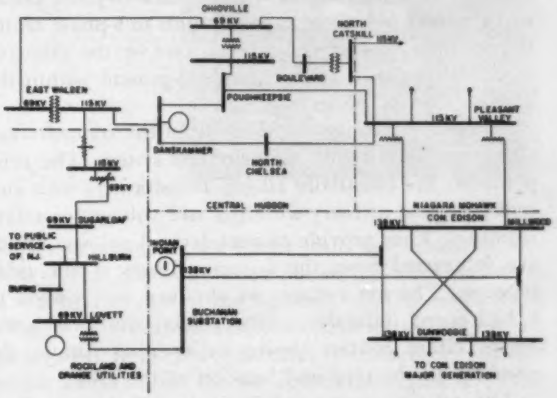

Fig. 8. Interconnection of Indian Point station to adjacent systems.

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Compensator Distance Relaying

Part I—General Principles of Operation

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THE COMPENSATOR distance relaying scheme is a new and different approach to the problem of relaying interphase faults on transmission lines. It differs from conventional distance relaying in that no one relay is assigned to any particular phase. Instead, one polyphase unit responds to all phase-to-phase faults, and a second polyphase unit responds to 3-phase faults. Between the two of these units, one or the other or both will respond to any 2-phase-to-ground within the desired zone of protection.

The system receives its name from the compensators which are a vital component of the system. The compensators are essentially air-gap transformers with current-energized primary windings and voltage secondary windings. They provide current-derived voltages which are subtracted from the system voltages at the relay location. The net voltages so obtained are applied to a high-speed induction cylinder relay unit which develops either contact closing or opening torque, depending on the type and location of the fault.

The cylinder unit used in both the phase-to-phase and 3-phase relay units is basically a polyphase induction motor. It has four poles and two sets of coils as indicated in Fig. 1. The coil windings are connected as shown to three terminals *X*, *Y* and *Z*. The connections are such that if a 3-phase voltage of *XYZ* phase rotation is applied to the terminals *X*, *Y*, and *Z*, the cylinder will rotate in a contact-opening direction. If the phase rotation becomes *XZY*, the cylinder will rotate in a contact-closing direction.

The basic a-c voltage and current circuits of the phase-to-phase portion of the compensator relay are shown schematically in Fig. 1. The system voltages V_a, V_b, and V_c are modified by the drop through the compensators to give the voltages V_X, V_Y, *and* V_Z at the terminals *X*, *Y*, and *Z* of the relay coils. The mutual impedance of each compensator is set so that it is equal to the desired line balance-point impedance in terms of secondary ohms.

For a *BC* fault at the desired balance point, the voltage drops in the compensators on the faulted phases

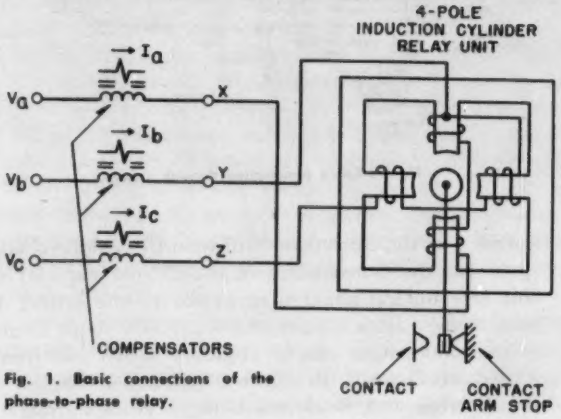

Fig. 1. Basic connections of the phase-to-phase relay.

will be equal, in secondary terms, to the line voltage drop from the relay to the fault. Thus, the voltage between terminals, *Y* and *Z* will be equal to zero, inasmuch as the *BC* voltage is zero at the fault. With V_{YZ} equal to zero, there will be no phase rotation of the voltages at the *X*, *Y*, and *Z* terminals, and the relay will have no electrical torque in either the contact-opening or contact-closing direction. This is a balance-point condition for the relay.

For a phase-to-phase fault anywhere within the protected zone, the compensator voltages combined with the system voltages will give a set of voltages for the relay unit with *XZY* phase rotation. For any phase-to-phase fault beyond the balance point or behind the relay (outside the zone of protection), the net voltages for the relay unit will have an *XYZ* phase rotation which produces contact-opening torque. Thus, the relay is inherently directional, and will have similar performance for all phase-to-phase fault combinations.

The 3-phase relay unit operates on the same general principle, but because of the symmetry of such a fault, only a single compensator is required. It is connected in the phase *A* potential circuit, and to give proper coverage for some 2-phase-to-ground faults, its primary is energized with $I_a - 3\ I_o$ current. With this arrangement, between the phase-to-phase and 3-phase units, the compensator relay will respond to all faults within the zone of protection except single-phase-to-ground faults.

The compensator principle of distance relaying provides a new approach to the relaying of transmission lines, with advantages unique to this system. By using compensators which are static circuit elements, in conjunction with an induction cylinder relay unit, complete phase fault coverage for each zone of protection can be realized using only two relay units. The use of fewer relay units results in increased circuit simplicity and greater reliability.

Digest of three papers, 58-26 (Part I), 58-20 (Part II), 58-19 (Part III), recommended by the AIEE Relays Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Winter General Meeting, New York, N. Y. Feb. 2-7, 1958. Published in AIEE *Power Apparatus and Systems*, June 1958, pp. 372-92.

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Part II—Design and Performance

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THE INTRODUCTION of a 3-phase compensator concept affords an entirely new approach to distance relaying. This new scheme has been designed so that one relay provides protection against all phase faults for a single zone. Transient overreach of the sensing unit has been eliminated. A single type of basic relay unit is used to interpret the output of the static compensator network and the moving element in the relay unit has been designed for low contact bounce at both low and high energy levels.

Response to 3-phase faults is provided by the 3-phase unit which consists of an autotransformer, one compensator, a cylinder unit, and some associated circuitry. The autotransformer provides an adjustment of voltage level from the potential transformer which is used in the setting of the relay. The main taps of the transformer are designated by the letter *S*. The fine taps are designated *M* and are located on a small buck or boost winding which can raise or lower the voltage level of the main taps.

The compensator which is fed by the output of the line current transformers has been designed as an air-gap transformer with a large internal air gap. It has been proportioned so that its mutual impedance has a known value adjusted by taps designated *T* from 0.87 ohms to 5.8 ohms in 30 per cent steps. These taps in combination with the autotransformer provide a range from 0.75 ohms to 20 ohms. The output winding of the compensator has two sections. One section in conjunction with a resistor provides a phase angle setting from 60 to 85° for the output voltage with respect to the input current. The other section is in series with the applied voltage from the line potential transformers as modified by the autotransformer. The output from the compensator subtracts vectorially from the modified applied voltage, which is proportional to IZ (I is the relay current and Z is the line impedance in secondary terms). When the line impedance to the fault (Z_F) is less than the compensator setting Z_c, the voltage from the compensator becomes greater than the line voltage drop to the fault in secondary terms. This reverses the phase sequence of the voltage applied to the relay and produces contact closing torque. The general equation for setting the ohms reach, Z, of the relay is

$$Z = \frac{TS}{(1 \pm M)} = \text{Zpri} \quad (0.9\ R_c/R_v) \quad \text{where } T, S, \text{ and } M$$

are taps on the relay, R_C is the current transformer ratio, and R_v is the potential transformer ratio.

Sensitivity to phase-to-phase faults is provided by three compensators, a cylinder unit, and associated circuitry. The operating principle of these compensators is identical to that of the 3-phase unit. Current-derived voltages of the compensator secondaries are subtracted vectorially from the potential transformer voltages which are modified by two autotransformers. Two adjustable resistors in phase *A* and phase *C* circuitry are used as a factory trimming adjustment to maintain the same reach on all phase-to-phase faults. The settings of the phase-to-phase unit are similar to those of the 3-phase unit and can be checked by using 3-phase voltages in combination with a single-phase current.

The polyphase compensator-type distance relay described in this article contains two tripping elements for single zone protection of all three phases. Static components make it possible for the two tripping elements to respond to 3-phase faults, to the three phase-to-phase fault combinations that occur within a preset protective zone. The compensator scheme makes it possible to use a minimum number of moving parts to perform a multiplicity of functions. The relay units are packaged so that the phase-to-phase and 3-phase units for each zone are in one case, thus making possible single-zone, 2-zone, or 3-zone schemes of protection. The co-ordination problem becomes simplified through the use of a single basic tripping element for all applications. The relay, when applied to a star-delta transformer, may be set using standard connections without the addition of auxiliary star-delta current or potential transformers. It also may be set without regard to overreach caused by d-c transients on high-angle lines. Construction of the relay is shown in Fig. 2.

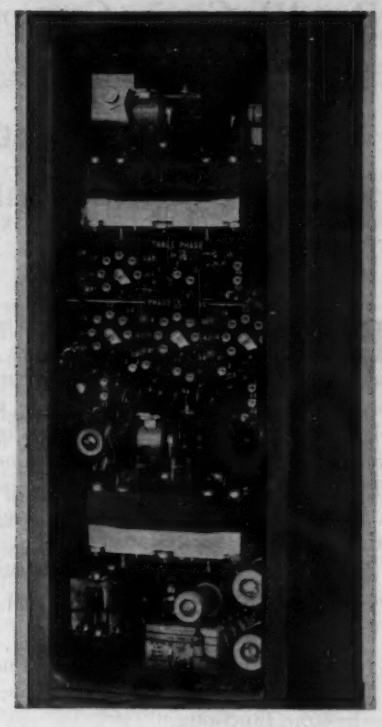

Fig. 2. Single zone compensator relay.

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Part III—Carrier Control System

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THE COMPENSATOR distance relays described in the two companion articles present an opportunity for considerable simplification of the trip and carrier-control circuits of a complete 3-zone distance carrier relaying system. The use of only two inherently directional polyphase distance units per zone, responsive to all phase faults in each zone of protection, reduces by at least one third the number of contacts associated with phase-fault protection.

The relay requirements for one terminal of distance carrier relaying using the compensator distance relays are as follows:

1. Compensator distance relay for zone 1 tripping.
2. Compensator distance relay for zone 2 tripping and carrier-stop functions.
3. Modified compensator relay for zone 3 tripping and carrier-start functions.
4. Time-delay relay for 2nd and 3rd zone time delays (Fig. 3).

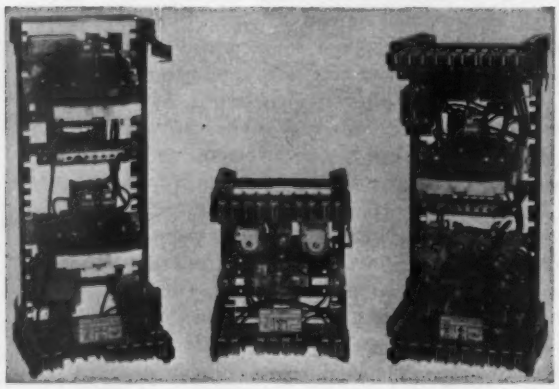

Fig. 3. Components of Carrier Control System. *Left*—directional overcurrent ground relay. *Center*—time-delay relay for zones 2 and 3. *Right*—carrier auxiliary relay, including overcurrent carrier-start unit.

5. Directional overcurrent ground relay (Fig. 3).
6. Carrier auxiliary relay (Fig. 3).
7. Out-of-step blocking relay (optional).

The compensator distance relays for zones 1 and 2 have been briefly described in Parts I and II of these three companion articles. The relay for zone 3 is similar, but is designed so that its operating characteristic circle includes the origin instead of passing through it. This is necessary for dependable carrier blocking for close-in external faults. In addition, the contacts of the third zone relay are arranged for circuit-opening carrier-start operation. The compensator distance relays for the three zones are given settings essentially the same as for other distance carrier relaying systems.

A single time-delay relay is used to obtain the second and third zone time-delay intervals. The timer uses a synchronous motor energized through a saturating transformer from two of the line currents. The timer is controlled by the second and third zone compensator relays. Thus, it will operate for any fault which operates either of these relays. Because of the circuitry associated with the compensator relays, a single timer relay is adequate for a set of three distance relays.

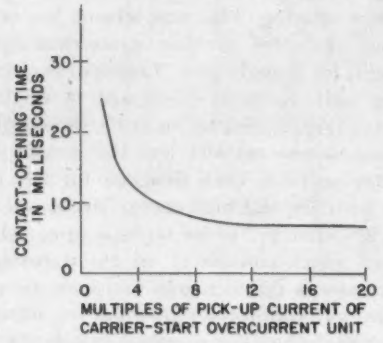

Fig. 4. Operating time of circuit-opening, carrier-start overcurrent unit.

For single-phase-to-ground fault protection, a directional overcurrent relay is used to control the removal of blocking carrier and to set up the carrier trip circuit. This relay consists of a 4-pole induction cylinder overcurrent unit, and a similar 4-pole directional unit which may be either current or voltage polarized. In addition, a dual-polarized relay is also available which uses two separate directional units for current and voltage polarization, respectively. The overcurrent unit in these relays is directionally controlled. The operating time of the carrier-start overcurrent unit in the carrier auxiliary relay is shown in Fig. 4.

The compensator relays make possible a significant simplification of the carrier control and trip circuits of the 3-zone distance carrier relaying system. Inasmuch as only two relay units are used for each zone of phase fault protection, there are fewer contacts in the complete relaying system. Careful attention to operating and resetting time of the various protective and auxiliary relay units has resulted in an ample time margin for proper co-ordination of the relays. The use of a single design of high-speed protective relay unit for all a-c types of measurement simplifies the co-ordination problem.

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A Review of Gaseous Dielectric Development

F. L. HOLLOWAY W. H. MEARS

A nontechnical review of the development of gaseous dielectrics. Topics discussed are history, action of gas insulators, problems in choosing a suitable gas, established uses for SF_6, and new gaseous dielectrics.

A CRITICAL PHASE of directing or confining electrical energy—getting it to go where you want it to go, or stay, within prescribed channels—is insulation. This is particularly true for high-voltage apparatus.

The trend in requirements for high-voltage equipment is toward higher operating voltages, units of minimum size and weight, greater safety, and lower maintenance costs. This means that the best in insulating materials is being sought—and used.

Why gaseous insulation? Why not just liquids or solids? Simply that the need for a dielectric in a confined or confinable space separating surfaces of high potential differences can often best be met with a gaseous dielectric. For some applications, solids cannot be used because they block the necessary dissipation of heat generated by the equipment; in other instances, solids would hinder necessary mechanical motion. For other applications liquids are not best because of a fire and explosion hazard associated with organic insulating liquids; large pressure surges on arcing; a prohibitive weight penalty, and—of increasing importance—noise transmission.

HISTORY

AIR WAS THE ORIGINAL GASEOUS DIELECTRIC, and is still used where gas insulation is needed and design requirements do not require a better gaseous dielectric. M. J. Gross has pointed out that in the development of X-ray apparatus, air was used in the early models.[1] It was gradually replaced by solid and liquid insulators, only to come into its own again when supervoltage equipment required prohibitive weights of transformer oil. A serious drawback to air in this case, however, was that it had to be compressed up to several hundred pounds per square inch in order to improve its dielectric strength to the point where it could be used to prevent arcing. It was easy to see that if other gases showed better dielectric properties, they could be used at lower pressures.

The early work of Charlton and Cooper (1937) and Pollock and Cooper (1939) demonstrated that certain fluorocarbons and sulfur hexafluoride (SF_6) were distinctly superior to air in terms of their dielectric strength.[2, 3] In November of 1940, General Electric was assigned a patent on the use of SF_6 as a gaseous dielectric.[4] The Russian investigator, Hochberg, reported the use of SF_6 in high-voltage condensers in 1942.[5] General Chemical Division of the Allied Chemical Corporation began making SF_6 on a commercial scale in the latter part of 1947. It was the first commercially available fluoride which was made directly from elemental fluorine. Subsequent work by several teams of investigators has tended to confirm that the best gaseous dielectrics are characterized by having fairly heavy and complex molecules having a high percentage of fluorine.

ACTION OF GASEOUS DIELECTRICS

THE REASONS why such fluorides show desirable dielectric properties are complex and not thoroughly understood. However, papers by Camilli and co-workers, and Howard, among others, throw considerable light on these problems.[6, 7]

It is probable that the ease of formation of stable negative ions is of primary significance in their prevention and quenching of arcs. Such negative ion formation in effect reduces the quantity and mobility of electrons which carry most of the current constituting an arc. The ability of SF_6 molecules, for example, to form stable negative ions is associated with its relatively large size or electron collision diameter, the low energy of formation of the SF_6 ion, and the ease with which the energy of an attaching ion can be stored within the various molecular motions of the molecule, thereby preventing subsequent dissociation.

In a purely qualitative sense, one can describe the action of these so-called "electronegative gases" as that of a sponge—a sponge which soaks up free electrons coming in contact with it, just as an ordinary sponge soaks up water.

CHOOSING A GASEOUS DIELECTRIC

IT WOULD BE CONVENIENT in screening various gases for dielectric properties if one had only to pass a sample of the gas between two charged plates of some "machine," read a dial, and record the dielectric strength. It is by no means that simple. It is not simple because the values one gets from the "machine" depend upon the construction of the machine itself, including the

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geometry of its parts and materials of construction; time factor in applying voltage; frequency of current; pressure of the gas, and still other factors. Differences in electrode shapes and gap distances, for example, can reveal conditions of appreciably different dielectric behavior in two different gases. Two gases may appear nearly equivalent in dielectric strength at narrow gap settings with electrode shapes which give rise to uniform fields, whereas the same gases may differ in dielectric strength by 10 to 30 per cent at wider gap distances or with electrode configurations where the nonuniformity of field is more pronounced.

Work has been under way for about a year now to develop a satisfactory standard dielectric gas test cell for preliminary screening purposes. The goal has been to develop a relatively simple test unit and procedure which will permit all those interested in gaseous dielectrics to make initial tests on gases under strictly comparable conditions. A recent report on this development, including an excellent bibliography on the topic of gaseous dielectrics, was given by M. L. Manning at the June 1958 meeting of the American Institute of Electrical Engineers.

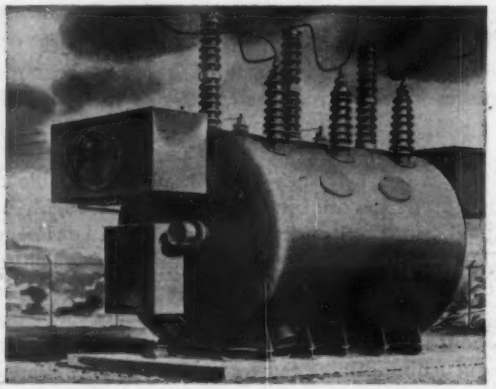

Fig 1. Artist's rendition of the General Electric SF_6-filled transformer built for Pennsylvania Power and Light Company. It is rated at 10,000 kva, 69 kv.

Factors other than dielectric strength also are very important in the choice of gaseous dielectric. The more important of these are: boiling point, melting point, vapor pressure, toxicity, chemical inertness, thermal stability, and price.

Carbon tetrachloride, for example, has a very good dielectric strength—6.3 relative to nitrogen at 1.0, both measured at atmospheric pressure in a uniform electric field—but its relatively poor chemical stability and its relatively high toxicity are major deficiencies. The boiling point (76 C) and freezing point (—22.6 C) of carbon tetrachloride also would preclude any significant commercial use.

Difluorodichloromethane (CF_2Cl_2) which is commercially available under the trade name Genetron 12, is a fairly good gaseous dielectric. It is inexpensive, nonflammable, and nontoxic. Its dielectric strength is 2.5 relative to nitrogen. Its boiling point is —29.8 C, which is fair, but not as low as desirable for outdoor installations. Its chemical and thermal stabilities are moderately good, its use being limited to an upper temperature level of about 100 to 150 C and even here in the absence of rubber and most plastics.

A large number of compounds have been investigated as potential gaseous dielectrics. The only one to achieve widespread commercial use, however, is General Chemical's SF_6. Some of the quantitative properties of SF_6 will be listed later. It is sufficient to point out here that it is physiologically inert (no toxic effects are shown by prolonged exposure of test animals to mixtures of 80% SF_6 and 20% oxygen); nonflammable; has a dielectric strength of about 2.2 relative to nitrogen (for 60-cycle current and uniform field); has good heat conducting properties under conditions where convection or pumping circulates the gas; is stable in the presence of most materials of construction up to temperatures of about 150 C; remains a gas under most use conditions down to a —63.8 C; and is available at moderate prices. The 150 C temperature is an arbitrary value suggested by the results of experimental study of the thermal stability of SF_6 in the presence of materials such as silicon steel, copper, aluminum, etc. Under ideal conditions, such as being in contact with quartz only, it is stable at temperatures as high as 500 C. These facts serve as an example of the general rule that the thermal stability of a given compound is dependent on its environment as well as its molecular structure.

It is apparent that this dielectric should be useful in a wide variety of high-voltage equipment, and it is. Three major uses for SF_6 are reported in the literature on the subject.

ESTABLISHED USES FOR SF_6

Transformers. G. Camilli and co-workers at General Electric are largely responsible for this development.[6, 8, 9] A recent transformer insulated with SF_6 which that company has offered is rated at 10,000 kva, 69 kv (Fig. 1). L. F. Kilham, Jr., R. R. Ursch, and J. F. Ahearn have pointed to the use of SF_6 as a padder gas above fluorochemical liquids in smaller "electronic" transformers.[10]

Interrupter Switches. Henry, Friedrich, and Reese have described the field tests and service experience of a 115-kv 1 million-kva SF_6 filled circuit breaker.[11] Lingal, Strom, and Browne have also shown that the a-c current interrupting ability of SF_6 in plain break arcs is about 100 times that of similar arcs in air.[12] This probably is because of the rapid rate of return to normalcy of SF_6 at or near zero current in the a-c cycle.

Radio and Microwave Frequency Power Transmission. Developments in radar and television transmission are requiring the use of SF_6 in place of air. Sulfur hexafluoride has been used extensively in "long line" coaxial cables. General Chemical's work with Airtron, Inc., indicated that at 9,375 mc the power carrying capacity of SF_6 was 7.6 times that for air.[13] J. W. Sutherland re-

ported the microwave power carrying capacity of SF_6 compared to air also. He found that at 3,000 mc the power carrying capacity of SF_6 was 10.5 times that for air.[14] Gibson and Miller have studied the use of SF_6 in the 2- to 16-mc range.[15]

Sulfur hexafluoride is also being used commercially in a wide variety of miscellaneous electrical devices including X-ray gear, cathode-ray accelerators, Van de Graaff machines, and television filterplexers.

NEW GASEOUS DIELECTRICS

ONLY SLIGHT MENTION has been made of gaseous dielectrics other than sulfur hexafluoride for the simple reasons that SF_6 is the only gaseous dielectric manufactured on a commercial scale especially for this purpose, and it has several years' history of proved performance. Another reason, of course, is that most other candidates for gas insulators have deficiencies of one kind or another which rule them out. It cannot be over-emphasized that factors other than dielectric strength play important roles in final determinations of choice of product.

The trends of technological developments being what they are and with the constant search for better ways of coping with old or new problems, it is possible that one or more other gaseous dielectrics may attain commercial status in the future. Such products may offer one or more properties superior to those of SF_6; however, because of price or physical limitations, they may find use only in specialized applications where their properties can be utilized to most advantage.

Promising candidates for new gaseous dielectrics are the so-called saturated 3 and 4 carbon members of perfluorocarbons. These are compounds containing only carbon and fluorine, with no reactive group or site present. They are the following: Perfluoropropane (Octafluoropropane or C_3F_8), Perfluorobutane (C_4F_{10}), and Perfluorocyclobutane (Octafluorocyclobutane, c-C_4F_8). Experimental quantities of C_3F_8 and C_4F_{10} are available from General Chemical Division and it is understood that experimental quantities of c-C_4F_8 are available elsewhere.

Table I lists the salient properties of these compounds compared with those for SF_6.[16]

Table I. Physical Properties of Selected Fluorogases

	SF_6	C_3F_8	C_4F_{10}	c-C_4F_8
Mol. wt.	146.06	188.02	238.03	200.03
B.P., °C	−63.8 subl.	−36.7	−2.0	−6.0
F.P., °C	−50.8	<−160	<−80	−41.4
Relative Dielectric Strength	2.2	2.2	2.8	2.8
		Vapor Pressure (psia)		
0 C (32F)	185	60.4	15.9	18.8
21.1C (70F)	325	114.8	34.0	40.1
38C (100F)	462	180.0	59.0	66.8

The relative molecular weights of these materials are roughly proportional to their filling densities and, thus, roughly proportional to their relative costs in filling a given unit, assuming that their cost per pound is the same. It is apparent that SF_6 has a distinct advantage here.

From the criteria of boiling point and vapor pressure, SF_6 is excellent, C_3F_8 is good and the C-4 compounds poor. Regarding freezing point, the −41.4 C for c-C_4F_8 is rather high; the others are good to excellent in this respect. It should be noted that the vapor pressure of SF_6 at its freezing point is 2 atmospheres, such that it provides "gaseous insulation" at temperatures substantially below its freezing point.

As indicated, the dielectric strength of the C-4's is about 25 per cent greater than for C_3F_8 or SF_6. The percentage overage in dielectric strength compared to SF_6 increases with increasing gap distance in nonuniform fields, with C_3F_8 also being better than SF_6 under these conditions.

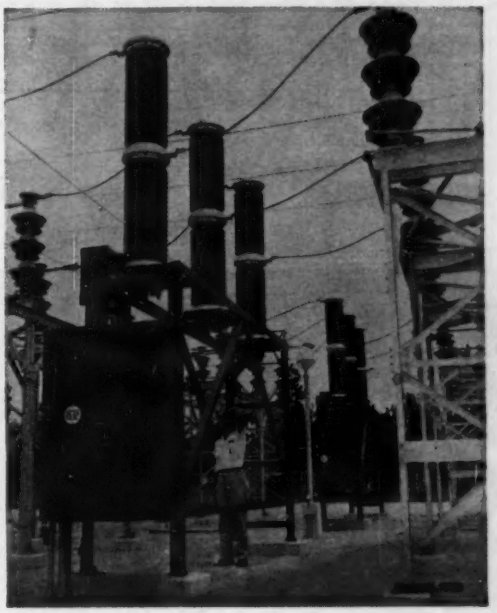

Fig. 2. These are 115-kv, 1,000 mva, SF_6-filled circuit breakers built by Westinghouse Electric Corp. for the Gulf Power Company.

OUTSTANDING PROPERTIES

PERHAPS the most outstanding properties of the perfluorocarbons, however, are their thermal stability and compatibility with materials of construction. Preliminary tests suggest that these materials can be used at temperatures of 50 C to 100 C higher than normally recommended for SF_6. Because in most applications an upper limit of 150 C is recommended for use of SF_6, the perfluorocarbons should be suitable for the range of from 200 to 250 C. This suggests they would be very useful in any high-voltage apparatus which operates at

high temperatures. Application to transformers is already under study and development. It is conceivable that other uses may capitalize upon their good dielectric properties in nonuniform fields.

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Germ-Killing Telephone

A telephone with a built-in sanitizing system which kills bacteria, molds, and virus within seconds after the mouthpiece is returned to its rest position has been developed.

According to G. R. Cobb, president of Danco Telephone Company, Inc., New York, the mouthpiece of the new telephone is arranged so that it rests on an automatic built-in sterilizing unit containing a Sterilamp tube which emits bactericidal radiation. Each time the mouthpiece is replaced to its normal position, the Sterilamp tube is activated; the ultraviolet rays it produces destroy any organisms which have been deposited on the transmitter piece by the previous user.

According to Dr. Rudolph Nagy, manager of ultraviolet development for Westinghouse, the Sterilamp tube used in the new telephone destroys bacteria and other micro-organisms deposited in the air or on exposed surfaces. He said the Sterilamp tube also produces controlled amounts of ozone. The ozone destroys odor molecules and imparts a clean fresh smell. He explained that the lamp used in the telephone works on the same principle as those used to destroy harmful bacteria in operating rooms, food packaging plants, refrigerators, pharmaceutical plants, and many similar applications.

Tests indicate that in the new Danco telephone sterilizing unit, influenza virus on the surface of the transmitter are destroyed within seven seconds. The harmful staphylococcus and streptococcus families are eliminated 3½ seconds later. The Sterilamp tube remains on for an additional 50 seconds to insure that no organisms have survived.

The sanitized telephone will be particularly useful wherever telephones are used by more than one person. It is believed the new unit would help materially to reduce absenteeism among employes.

The Sterilamp tube used in the new unit has a life of about 4,000 hours. It should last about 3 years in average telephone use. It is inexpensive and simple to replace in the Danco telephone.

Thermal Impedance of Cooling Fins

E. J. DIEBOLD
MEMBER AIEE

WERNER LUFT

SEMICONDUCTOR DEVICES are often bolted to a metal plate which acts as a cooling fin. This paper shows a determination of optimum design proportions.

Fin dimensions are normalized with the natural radius. The natural radius of a sheet metal used for cooling depends only on its thickness, thermal conductivity, and heat transfer coefficient. Well-designed fins have a radial width which is approximately equal to the natural radius.

In the earlier literature, "fin efficiency" is defined as the ratio of total heat dissipated by a cooling fin to the heat dissipated under the same conditions by an identical fin of infinitely conductive material; the name of "impedance ratio" would be more appropriate.

Fig. 1 shows curves of constant efficiency vs the ratio of outer to inner fin radius on the abscissa and the ratio of natural to inner fin radius on the ordinate. Optimum fins, i.e., fins of minimum volume, have an "efficiency" of approximately 50%.

For the design of fins with known inner radius (usually with semiconductors) the concept of fin effectiveness is very useful. Define fin effectiveness as the ratio of heat dissipated by the cooling fin to the heat dissipated by the base area (circle having inner radius of fin), assuming identical heat transfer constant and temperature rise at the inner radius.

Fig. 2 (same co-ordinates as Fig. 1) shows curves for constant fin effectiveness. The figure contains also curves for constant normalized fin volume, permitting direct comparison of effectiveness and volume. Where the curves of constant fin volume are tangent to the curves of constant fin effectiveness, there is a maximum of effectiveness at constant volume. Connecting all the points along which the curves are tangent gives the dotted line in Fig. 2. This line represents the optimum relation between fin effectiveness and volume and establishes, simultaneously, a relationship between the ratios of outer to inner and natural to inner radii. Accordingly, geometrical proportions of cooling fins should be near the dotted line in Fig. 2.

To design an optimum fin for a required heat dissipation, calculate the heat dissipated by the base area. The ratio of required heat dissipation to the dissipation from the base area is the required fin effectiveness. The intersection of this effectiveness with the dotted line in Fig. 2 gives the ratios of outer to inner and natural to inner radii which, for given material and heat transfer mode, determines the fin dimensions.

Digest of paper 58-926, recommended by the AIEE Semiconductor Metallic Rectifiers Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Summer General Meeting and Air Transportation Conference, Buffalo, N. Y., June 22-27, 1958. Scheduled for publication in AIEE *Communication and Electronics*, 1958.

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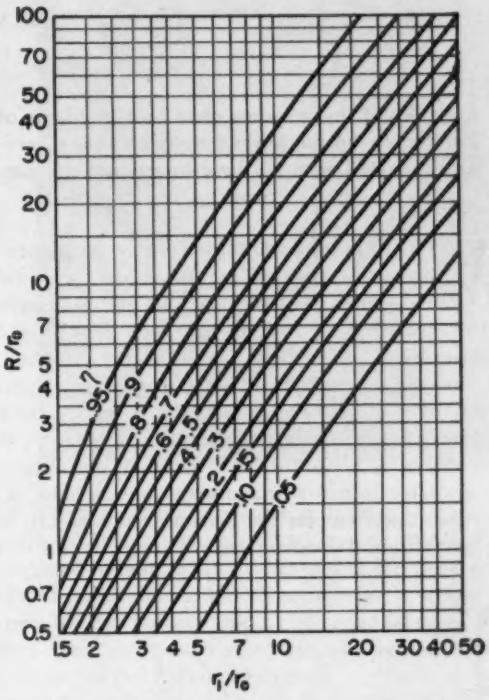

Fig. 1. Curves of constant fin efficiency η plotted against ratios of outer over inner and natural over inner radii.

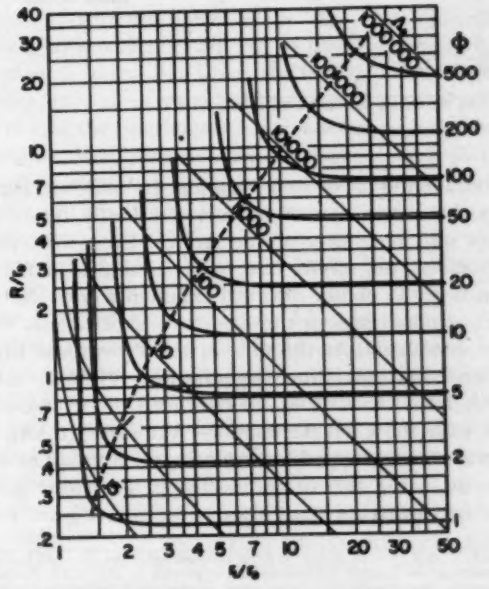

Fig. 2. Curves of constant fin effectiveness Φ and constant volume Λ plotted against ratios of outer over inner and natural over inner radii.

Public Air–Ground Telephone Service Trial

L. M. AUGUSTUS

A survey of the growing need and problems of developing an air–ground radiotelephone service connected with the land-line telephone network.

WHILE radio communication to airplanes has been in everyday use for many years, until September 15, 1957, the only public telephone service available to aircraft has been that furnished through coast stations which have been established for the provision of telephone service to ships. Approximately 600 aircraft are registered for service through coast stations operating in the 2-mc frequency range. The service is not satisfactory in many respects. It is not available in many inland areas and, because of the crowded conditions on the marine channels, fast moving aircraft are frequently unable to receive any service before landing at their destination. In addition, atmospheric noise at these frequencies seriously limits the range and reliability of the service. Even with these limitations, the service has grown as shown in Fig. 1.

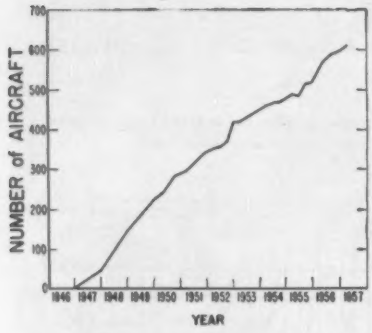

Fig. 1. Growth of aircraft radiotelephone service.

In order to obtain practical experience with the aircraft communications problem, two experiments have been conducted. At the time of the Provisional International Civil Aviation Organization (PICAO) meeting in Indianapolis, Ind., in October 1946, in co-operation with the Civil Aeronautics Authority (CAA), an airplane was equipped for operating with urban mobile stations in the 152- to 162-mc range. This installation was used experimentally during the meeting for communication through the Indianapolis urban mobile land station facilities which were, at the time, undergoing test. In addition to the experiments with the CAA airplane, a United Air Lines Douglas *DC-6* plane was fitted with 152- to 162-mc land mobile equipment and experimental calls were made during the inaugural flight and certain other flights thereafter. The tests indicated that an aircraft flying at altitudes from 10,000 to 20,000 feet would cause interference with land mobile stations using the same channel within a radius of 200 miles or more. The experiments showed conclusively that a good grade of telephone service could be given to aircraft employing frequencies in the 150-mc range but that channels separate from those employed for land mobile telephone service would have to be used.

The growth in the number of civil aircraft has been phenomenal since the end of World War II. According to current estimates, a total of about 65,000 active civil aircraft are flying more than 13 million hours a year. Several aircraft user groups have repeatedly expressed a growing interest in public air–ground radiotelephone service connecting to the land telephone network. This was specifically expressed by the National Association of State Aviation Officials (NASAO) in a resolution adopted by the board of directors in Washington, D. C., on February 2, 1956, and submitted to the Federal Communication Commission (FCC). This resolution together with a request from the National Business Aircraft Association (NBAA) for a "Special Service Communications Channel" was subsequently considered by Special Committee 56 of the Radio Technical Commission for Aeronautics. Since that time, several informal meetings have been attended by representatives of commercial airlines, military services, operators of executive and private aircraft, radio equipment manufacturers and telephone companies. The interest expressed at these meetings indicates that there is a compelling need for air–ground telephone service connected with the land-line telephone network.

Early in 1956, a Government–industry meeting was held in Washington under the chairmanship of C. A. Petry of Aeronautical Radio, Inc., to discuss "in-flight radiotelephone service to aircraft."

At subsequent meetings with representatives of manufacturing companies interested in building airborne radio equipment—the United States Independent Telephone Association, Aeronautical Radio, Inc., and the Bell System—it was generally recognized that the telephone industry is in the best position to provide the ground facilities for public telephone service to air-

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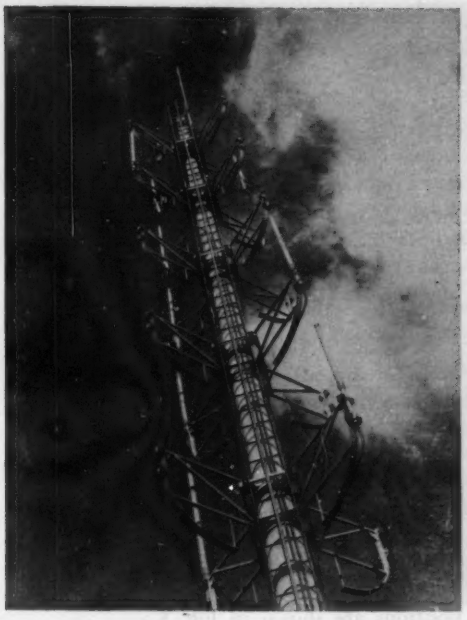

◄ Fig. 2. Antenna installation, Chicago, Ill.

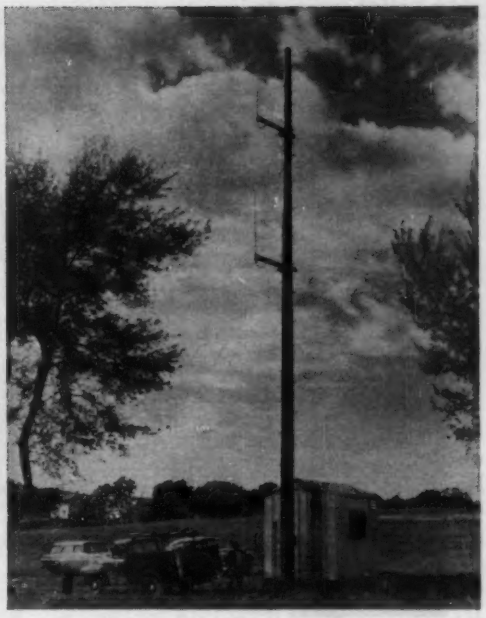

Fig. 3. Detroit transmitting and receiving station. ►

planes. In order to obtain suitable frequency allocations to provide the numbers of channels such a service may need within a few years, it is necessary to develop plans for service on a nation-wide basis.

TRIAL

As an aid in evaluating some of the questions encountered in developing such plans, a limited trial has been undertaken with ground stations at Detroit, Mich., and Chicago, Ill. The purpose of the trial is to provide needed technical data and traffic operating experience under actual flight conditions over a substantial part of an important route.

The frequencies used are 454.95 and 459.95 mc, normally assigned to the Domestic Public Land Mobile Service. These frequencies were chosen in order to obtain transmission information for frequencies well above those presently used for commercial operational air–ground communication. Theoretical consideration of path loss and antenna requirements lead to the conclusion that frequencies no higher than those in the lower part of the uhf band will be feasible without appreciably restricting the range. These are also the highest frequencies for which commercial mobile equipment is readily available. Under a developmental grant, the FCC has authorized the use of these frequencies at Chicago and Detroit for service to aircraft until September 1959. Fig. 2 is a view of the antenna installation on the Field Building in Chicago. Fig. 3 is a view of the Detroit antenna installation at Dixboro, Mich. The Detroit site is in relatively flat open country. It should be noted that the Chicago antenna installation is approximately 535 feet above the surrounding land while the Detroit antenna height is approximately 50 feet.

Tests at these widely different sites should provide useful information for most base stations which would normally be encountered for a nation-wide service. Frequency modulation (FM) was employed for these tests in view of its demonstrated advantages for a service to be used by the public. One of these advantages, the capture effect, appears to be of unusual significance in air–ground service where co-channel interference is a principal problem. The capture effect can be illustrated by analysis of a tape recording taken in a *DC-3* plane travelling 180 mph at an altitude of 8,000 feet on a direct route from Detroit to Chicago with transmitters at both these cities operating on the same frequency, modulated by different talkers. At the beginning, while the plane is in the area where the Detroit station is controlling, only the Detroit talker is heard. As the plane moves into the interference zone, a heterodyne appears, caused by the Chicago station. The impairment to the Detroit transmission is slight for a period of about a minute and a half, then rapidly becomes worse until the intelligence is completely lost because of the near equality of the two received signals. The transition period lasts about a half minute, before the Chicago talker is heard identifying the Chicago station, with the Detroit talker just apparent in the gackground.

With a ground speed of 180 mph, the half-minute transition represents 1½ miles of flight. Other recordings taken at higher altitudes indicate a more extensive zone of interference as might be expected from the greater overlap as altitude is increased.

Because the coverage areas of the two stations overlap considerably at high altitudes, the operating practice will be such that the two stations will not transmit simultaneously if either is working an aircraft in the interference zone. By an arrangement including a coordinating circuit and monitoring facilities each operator will know when the other base station is handling

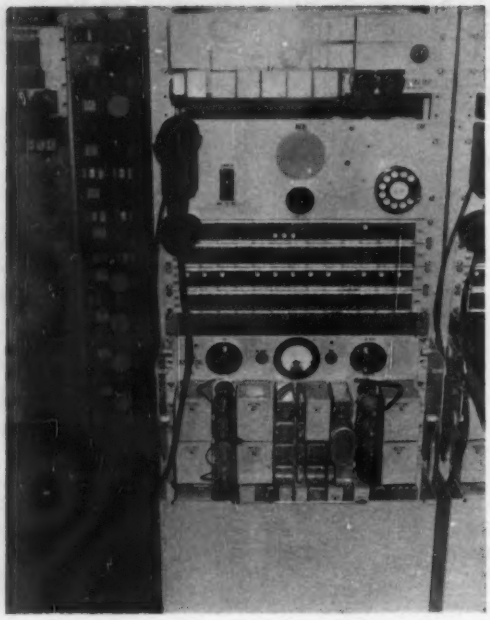

Fig. 4. Western Electric G-2 control terminal.

traffic and whether the aircraft using the channel is in the overlap zone. Under these conditions, she will not energize the local transmitter.

TRANSMITTING AND RECEIVING EQUIPMENT

THE EQUIPMENT ARRANGEMENTS in the Detroit station used in this system were designed by the Bell Telephone Laboratories to incorporate the features which have been found to be desirable for common carrier mobile radio services over the past 10 years. For example, an r-f indicating device is coupled to the transmitter output to provide an indication to the traffic operator that the transmitter is energized and she may dial the called party. This same feature will also indicate by the automatic alarms to the technical attendant, a failure of the transmitter, or a false operation should the transmitter radiate for any reason other than a signal from the remote control equipment.

The receiver is conventional in design—a double conversion superheterodyne with two grounded grid r-f stages. The electronic squelch of the receiver has been disabled and the normal noise voltages developed in the receiver are used to control a carrier-operated relay. The relay contacts are connected in such a manner that an idle receiver has a ground applied on the grid of the audio output stage. When a carrier is received and the receiver quiets, this ground is removed and transferred to a control circuit which indicates to the remote-control equipment that a signal is being received. The recovered modulation of the incoming signal is then allowed to pass through the receiver and ultimately to the aviation service operator.

Vertically polarized omnidirectional gain antennas were used at both Chicago and Detroit. At the Detroit station, arrangements were provided to permit observing the effect of small changes in the height and to determine the need for height diversity. This can also be seen in Fig. 3.

The transmitters used at both stations were phase modulated, having a nominal power output of 15 watts with very good frequency stability. The use of cavity filters in a diplexing arrangement enables the operation of the transmitter and receiver simultaneously from a common antenna.

CONTROL EQUIPMENT

IN PLANNING for this new service, it was decided that the system arrangements should be the same, at least in the beginning, as Detroit's existing land mobile common carrier services. This allows the station to utilize the Western Electric *G2* control terminal, shown in Fig. 4, which has proved very satisfactory as the intermediate connecting apparatus between the radio equipment and the "Aviation Service" operator, who supplies the final connection to the land telephone. The operator positions are shown in Fig. 5.

The control terminal does many thing to simplify the use of radio circuits by Detroit's traffic operators, but its principal functions are to convert 4-wire to 2-wire operation, supply signaling tones for dialing the mobile station, and maintain a relatively constant audio volume to modulate the transmitter. These functions are discussed in the following paragraphs.

1. The standard land telephone is connected to the central office, and ultimately to any other telephone in the nation-wide network by means of a single pair of wires over which the user both talks and listens. Contrasted with this, the radio circuit has separate talking and listening equipments which break the communication path into two one-way circuits called 4-wire operation. In the control terminal, the talking and listening paths are bridged to the 2-wire line by a resistance network which delivers the proper audio level from the receiver to the switchboard and also to the transmitting

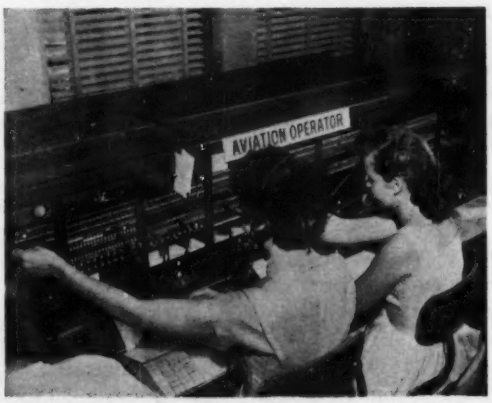

Fig. 5. Switchboard positions, Detroit, Mich.

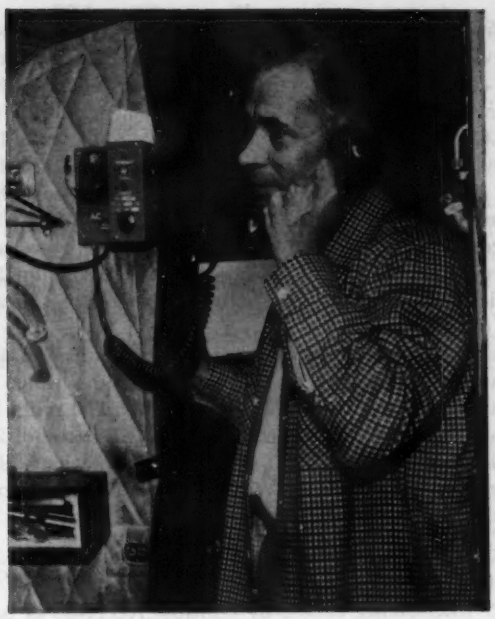

Fig. 6. Control unit and noise-canceling handset.

path for modulation of the base transmitter. By modulating the base transmitter with the received audio signal, the station can function as a repeater and furnish mobile-to-mobile communication over the coverage area of the base station.

2. The signaling method adopted by the Bell System utilizes a two-tone sequential system using the frequencies 600 and 1,500 cycles per second. The arrangement is such that the tones are sent alternately, each transition of tone resulting from a pulse of the operator's dialing equipment. Inasmuch as the number of pulses corresponds to the value of the digit dialed, the number of tone transitions is equal to the dialed digit. The mobile selector will advance one step for each transition of tone. If the selector is set up properly, a signaling contact will close when the dialing is completed. Five-digit telephone numbers will be assigned, the sum of the digits being equal to 23, 24, 25, or 26, with the digit 1 not used, and zero equal to 10. The digit 1 is not assigned because it is automatically transmitted as a clearing signal to the mobile receivers to set all selectors to the start position at the beginning and end of the dialing period.

3. Because of the nature of the telephone plant and telephone users, we have the additional problem of attempting to provide suitable modulation of the transmitter on every call from any telephone. The range of audio levels received at the aviation switchboard from land subscribers is expected to be from zero volume units to —40 volume units (vu), the distribution following a normal distribution curve. To compress this range of volumes to values which will allow good modulation on the great majority of transmission, the terminal includes a self-adjusting variable-gain amplifier which will deliver zero ± 4 vu to the transmitting cable pair.

The electrical noise interference aboard the *DC-3* was found to be inconsequential at these frequencies. The high ambient acoustic noise in the plane was largely overcome by the use of a noise canceling microphone. The use of a conventional handset receiver as shown in Fig. 6 permitted satisfactory reception over the high plane noise.

RESULTS

A LARGE VOLUME of propagation data has been obtained by recording the field strength from the plane while in flight along various radials and at several different altitudes. Analysis of these data has not been completed at this time, but it appears with the powers and antennas used that coverage is confined to regions lying well above the radio horizon, which is the optical horizon modified by a factor of 4/3 to account for average refraction in the atmosphere. For example, with a 50-foot antenna at Detroit, the radio horizon to a plane at 10,000 feet is 150 miles. In actual practice, the range obtained over relatively flat terrain was some 110 to 125 miles. Along a radial where the terrain fell off toward the lake in a manner to add to the effective height of the Detroit station, the range was some 25 miles greater. With the 535-foot base station antenna at Chicago, ranges approaching the radio horizon were obtained. To a plane flying at 10,000 feet, the radio horizon is approximately 175 miles. This is indicated in Fig. 7, which shows the approximate coverage areas of the Chicago and Detroit stations to aircraft at altitudes of 5,000, 10,000, and 20,000 feet.

At the coverage limits, the service was found to cut off in an abrupt manner. Particular attention was given to lobing effects caused by interaction of direct and ground reflected waves as has been so adequately described in the articles by Bureau of Standards personnel in IRE *Proceedings* April and May 1952. It appears that the lobing structure is less well defined than theoretical considerations would indicate, presumably

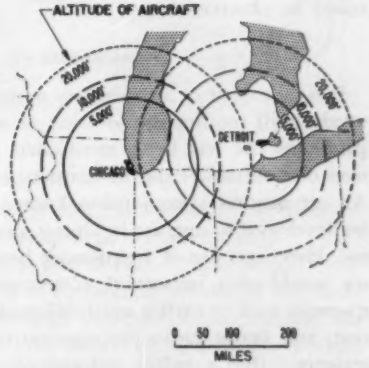

Fig. 7. Approximate coverage areas.

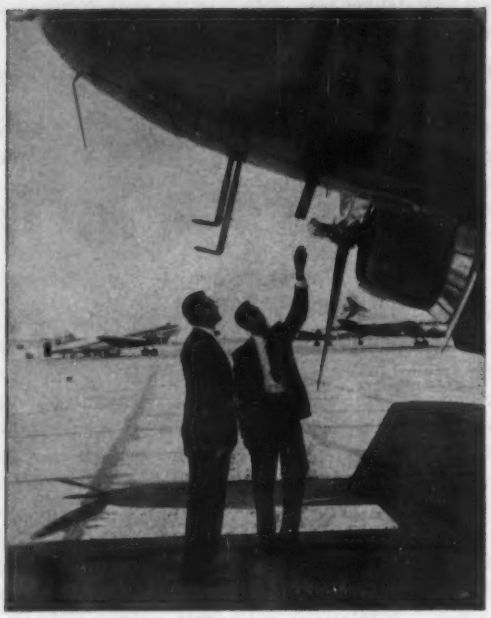

Fig. 8. Location of antenna on DC-3 test aircraft.

caused by the presence of multiple reflections from terrain irregularities. Lobes were found to be more numerous from the Chicago station using the 535-foot antenna as would be expected from theoretical considerations.

The antenna installation on the General Motors Corporation *DC-3* (Fig. 8) resulted in a nonuniform pattern which means that the coverage range will depend somewhat on plane orientation.

When the plane flew through the region directly above the ground station, wide excursions of field strength were experienced but no "cone of silence" could be observed.

PROBLEMS

DEVELOPMENT of an adequate nation-wide air–ground service will require the solution of several outstanding problems. As has been mentioned previously, allocation of a suitable band of frequencies is a prerequisite. An air–ground system using known techniques could be developed to operate in almost any band below 1,000 mc. However, use of frequencies between 100 and 500 mc would offer important advantages over higher frequencies such as earlier availability of equipment, lower cost, and better radio propagation characteristics. It is estimated that a public radiotelephone service for aircraft will require 40 to 50 channels on an FM basis to provide adequately for the traffic which will develop in the next 8 to 10 years.

As previously indicated, the present service is operating under a developmental grant from the FCC and, without further authorization from the Commission, service must end in September 1959. The existing trial has received the enthusiastic support of the entire aviation industry. An immediate need exists for the present service not only to be continued but also to be extended to cover the more important air lanes. The Bell System has, therefore, on March 31, 1958, petitioned the FCC as a first step to extend the service to the east. The service would then cover cities originating one third of all commercial air travel in this country and more than one fourth of all private flights. We believe that adding three stations near Pittsburgh, Pa., Washington, and New York, N. Y., will provide a coverage corridor 200 miles wide extending from 100 miles west of Chicago to the East Coast.

High-flying aircraft have a greater transmission range than low-flying aircraft. For example, the range as limited by the radio horizon is less than 100 miles for a plane flying at 4,000 feet and may be in excess of 250 miles for a plane flying at 40,000 feet. It is evident that any system engineered to provide coverage for a particular altitude would result in:

1. Gaps in coverage between base stations for aircraft flying below this specified altitude.
2. Interference caused by multiple reception of base station signals by aircraft flying above this specific altitude. The co-channel interference problem demonstrated by the tape recording can be considerably more severe unless careful attention is paid to this factor.

A problem which has undoubtedly occurred to you is that of maintaining a continuous conversation to a plane flying between two base station coverage areas. Liberal use of extensive telephone plant may be necessary to avoid the inconvenience of re-establishing the connection.

Electronic Enlarger

A unique electronic system which makes miniature target drones look like giant intercontinental bombers has been developed by the Sperry Gyroscope Company. The new system—called SEE, for Speary Echo Enhancer—was employed in a series of successful flight tests at Cape Canaveral, Fla., to help check the nation's SAGE air defense network.

By enlarging the pips—electronic "pictures"— which denote approaching aircraft on radarscopes, SEE makes possible use of small, relatively inexpensive target missiles and drone aircraft to simulate attacks by large enemy bombers.

The system consists of a Sperry traveling wave tube, miniaturized power "package" and antenna, weighing in total less than 20 pounds. Mounted within an aircraft or target drone, the equipment detects pulses from ground radars and sends back signals of greater intensity to create pips of any desired size on the ground radarscopes.

Zig-Zag Configuration for Ring-Bus Substation

R. N. CONNELLY
ASSOCIATE MEMBER AIEE

R. F. GIBBONS
MEMBER AIEE

THE NEW HEDGE SUBSTATION of Sacramento Municipal Utility District, located a few miles southeast of Sacramento, Calif., is designed to receive firming power over two lines from Pacific Gas and Electric Company plus substantial amounts of power from the U. S. Bureau of Reclamation Central Valley Project and from the new Upper American River Project, all at 230 kv. The 230-kv supply is transformed for use in a 115-kv section of the substation and also for use in a 69-kv section.

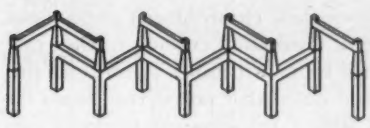

Fig. 1. Outline perspective for zig-zag structure for support of 230-kv lines, ring-bus, and disconnecting switches.

Because of there being four possible sources of 230-kv power supply normally available and only two load lines to the transformers, the use of a ring-bus switching scheme was indicated. The advantages of the ring-bus scheme thus are available in their entirety. These are that only one circuit breaker per line is required; the number of disconnecting switches and insulation points is small; extra buses are not required; relaying is not overly difficult; and when a line is disconnected the ring may still be closed.

Study of available ring-bus station designs and of the limited space of the site led to adoption of the well-known vertical-plane, ring-bus arrangement in which the two parts of the bus are above and below instead of on the same level. Detailed analysis of the design, however, indicated the advisability of adopting a simplified form—a zig-zag configuration—illustrated by Figs. 1 and 2. As compared with the conventional vertical-plane, ring-bus arrangement, the zig-zag design in the instance of the 230-kv structure reduced weight of steel by 11%, footing cost by 40%, and reduced the number of insulation points by four per circuit breaker.

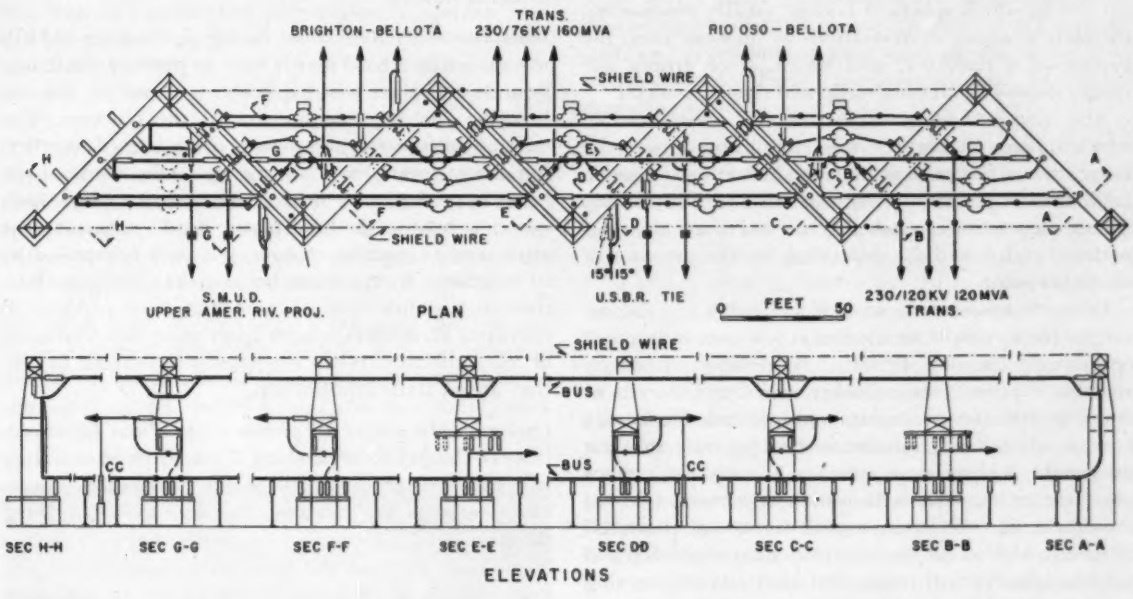

Fig. 2. Plan and sectional elevations of 230-kv section, showing zig-zag structure, lines, ring-bus, bus-sectionalizing and line-disconnecting switches, their connections and accessories. The bus-sectionalizing switches are independently mounted on small structures located directly beneath the cross-support framing of each bent.

The clear side entrance to each circuit breaker bay is also believed to be advantageous because of its ready admission of maintenance equipment, particularly for cleaning insulators. This feature along with the marked reduction of insulation points is expected to be effective in reducing operational hazards.

Digest of paper 58-1008, "Zig-Zag Configuration for High-Voltage Ring-Bus Substation," recommended by the AIEE Substations Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Pacific General Meeting, Sacramento, Calif., Aug. 19-22, 1958. Scheduled for publication in AIEE *Power Apparatus and Systems*, 1958.

R. N. Connelly is with the Sacramento Municipal Utility District, Sacramento, Calif.; R. F. Gibbons is with the Federal Pacific Electric Co., San Francisco, Calif.

Electrospherics and Magnetospherics

A. D. MOORE
FELLOW AIEE

This first part of a two part article discusses the interesting and dramatic effects displayed when tiny spheres, usually of magnetic material, move or are driven over the surface of a dielectric. Demonstrations of these phenomena may be made by simple means and at low cost, in terms of the equipment described.

Part I

A CONSIDERABLE BODY of electrical literature is concerned with the behavior of charged particles and the influence of electric fields on charged particles. This article presents some new observations in which spherical bodies, usually conducting, themselves cause electrification by motion over the surface of a dielectric; and which, if of proper size range, display interesting static and dynamic effects.

Also described are a number of new phenomena in which spheres of magnetic material of appropriate size range, when influenced by an alternating magnetic field, do strange, unexpected, and often very fascinating things, depending on whether or not they are magnetized; and sometimes depending on the presence of electrification.

Demonstration of these new behaviors can be arranged for by simple means and at low cost, in terms of equipment described herein. The demonstrations invariably captivate the onlooker, whether innocent of scientific training or highly sophisticated. Some may remain without application, interesting only in their own right. Others may serve as analogs for various other goings-on, such as Brownian movement, thermal movement of molecules, crystal formation, bacterial chaining, and so on. In any case, electrospherics and magnetospherics will prove that electrical engineering can be a lot of fun.

All experiments using an alternating magnetic field were done at 60 cycles per second, unless specifically noted otherwise.

ELECTROSPHERICS

Definition. When spheres of appropriate size and mass are shaken, moved, or rolled across an appropriate dielectric surface, thereby becoming charged and giving to the surface an opposite charge, various static and dynamic phenomena can be demonstrated. These phenomena will be called electrospherics.

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Discovery. When developing sandbed types of fluid mappers some years ago, the writer acquired some nickel shot, much of which is very smooth and quite round. These little balls, about 18 mils (0.018 inch) in diameter, are shown in Fig. 1. As they were poured into a polyethylene container, it was noted that they became electrified. Shaking them across the bottom further electrified them. Many workers in different fields have been shown these electrospheric phenomena, with a high degree of fascination ensuing in each case. Only one or two had seen such things before, and they were people who had noted that polystyrene beads distribute themselves with a spacing-apart tendency over the inner surface of a glass bottle, when the bottle is tilted or shaken.

Distribution by Repulsion. In Fig. 1, the mass of balls was shaken in a hard plastic bowl to produce electrification. It was then tilted quickly to about 45 degrees, bringing the far side up toward the observer. The spheres rolled down and most of them massed together; but many sprang back up again, to distribute themselves at random over much of the bottom surface. Each sphere is held to the hard plastic bowl's surface by the attraction of opposite charges. But each is repelled by its neighbors by repulsion between like charges. Here, then, is a simple way to cause numerous particles to distribute themselves, spaced apart at random and more or less uniformly. When the spheres have come to rest, they are in static equilibrium.

Dynamic: Movement of Spheres about Their Locations. If weak charges occur, shaking a polyethylene container will cause all or nearly all of the distributed shot to flow around to new locations. But with enough shaking to give strong electrification, each sphere becomes "tied" to its home on the dielectric surface. Thereupon, mild shaking or vibration of the container will cause all of the spheres to oscillate in various ways, each in the little region it has staked out for itself.

In this dynamic situation, each sphere is, of course, still acting to repel its neighbors. Each sphere affects the movement of nearby spheres. This is not necessarily a true analog for the thermal movement of molecules in a solid, but it is effective as a visual demonstration of the ideas involved.

Fronds, Branches, Chains. These formations are best observed in a polyethylene container with a reasonably flat bottom. Such vessels are available for storing foods in the refrigerator. After repeated shaking of the spheres across the bottom to get strong electrification, the vessel is tilted a little. Various effects become

evident, if this operation is repeated time and again, and closely watched. Fronds, branches, and chains of spheres will form at the upper edge of the mass of spherical shot, as distributed spheres pour down to the mass in the tilted container. Or, with a slight amount of tilting, patches of monolayers will form on the bottom, and their edges will show these formations.

If these phenomena are viewed in terms of possibly analogous phenomena, some light, for example, may be shed on crystal growth.

Streaming. Streaming, shown in Fig. 1, is a striking dynamic phenomenon in electrospherics. As described previously, the bowl had already been tilted. Next, the cup was rotated a little by drawing the thumb back and moving the finger forward. The mass then had to readjust.

Normally, the upper spheres at the left would tend to roll downhill along the upper edge of the mass, to the right. But the presence of charge does not permit that. These spheres take off, leave the edge, stream upward away from the edge, flow across and among the distributed spheres, and come to rest somewhere to the right. This must be seen to be appreciated. It is best seen in a flat-bottom polyethylene container.

The picture was taken at 1/50 second exposure, which was too long to stop the motion. Looking closely, one can see many of the nickel shot showing streaks of movement.

Here, in a little bowl, one gets at least a rough simulation of what goes on when electrons are thrown out of a hot cathode, but if there is no potential gradient to make them leave home, they must return again. Other simulations of somewhat analogous phenomena may occur to workers in various fields.

Size of Spheres. Spheres only a few mils smaller than those described above will electrify, but will refuse to display dynamic effects. Their mass is too small, as compared to the electric forces, and they simply stick tight to their chance locations on the dielectric surface.

Going the other way, metallic spheres a few mils larger begin to be so heavy as compared with the electric forces acting that electrification by shaking by hand can hardly be made strong enough to get the several effects described. (Later in the article, it will be found that larger spheres do respond, but more movement will be required than that induced by hand.)

Thus, it was a stroke of luck that the writer's observation of electrospherics happened to be made with nickel shot of somewhere around the optimum size.

The source of the nickel shot is not given, for these came from an experimental batch, and may be unobtainable. Later, suitable shot that is available will be described.

Other Electrospheric Effects. Additional effects will be taken up subsequently, where they appear in connection with magnetospheric phenomena.

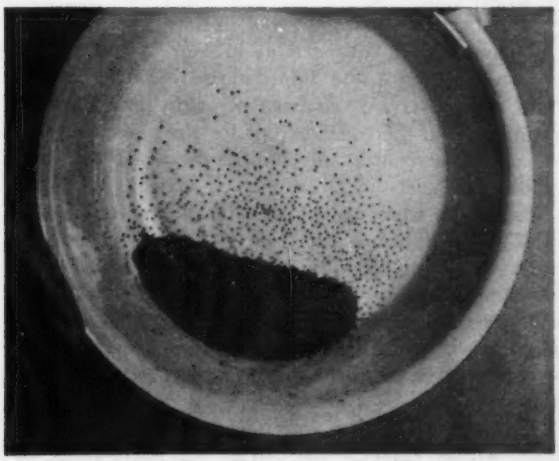

Fig. 1. Electrified balls spaced out over sloping bottom of a bowl. Streaming is displayed by balls showing movement.

MAGNETOSPHERICS

Definition. When spheres of magnetic material are acted upon by an alternating magnetic field, various static and dynamic phenomena can be demonstrated, depending on whether or not the spheres are magnetized, and depending in some cases on the presence of electrospherics. These phenomena will be called magnetospherics.

Discovery. Again, luck entered in; and again, in connection with fluid mappers. Back in 1943, some hard cast-iron shot had been acquired from an Adrian, Mich., firm, and the writer had copper-plated it to stop rusting. The size was about the same as that of the nickel shot.

In March 1958, the writer wanted to delineate an alternating magnetic field with iron filings. No filings being at hand, the cast-iron shot were tried. They worked remarkably well, but some of them began to "dance." They moved rapidly in and out among their quiescent comrades, a phenomenon which was unexpected, confusing, and stimulating.

The suspicion that these dancers might somehow have become magnetized was readily proved. A single little dancing ball was heated, whereupon it refused to dance; remagnetized, it danced again. There was no hint on that day, that all spare time for some months to come would be totally occupied with experimenting, theorizing, research, and the utterly entrancing business of seeing the birth of one new phenomenon after another.

Spheres as Synchronous Motor Rotors. The early experiments were done with a vertical air-core solenoid carrying alternating current, with a horizontal glass plate mounted on top. The dancing shot were allowed to cavort inside of a ring on the plate or in a bowl resting on it. In addition to the vertical component, this field had, away from the axis, a strong radial (horizontal) component. It was not then known that the horizontal component is undesirable. However, there was a dance.

After it was recognized that a ball might be rolling along as a synchronous motor rotor, the stroboscope gave good vertification. On the straighter parts of a path, the ball rolled approximately one revolution in one cycle. Complete vertification came later, on the "race track."

The Ball Ballet. Soon, hundreds or even several thousands of tiny magnetized cast iron shot were put into action, although a good a-c field conformation to induce the action had not yet been worked out. Seeing a great number of balls weaving in and out among each other of course led to the designation, "the ball ballet."

Accounting for the Ball Ballet. Among the factors making this display possible are the following:

Self-starting. If the magnetized ball is small enough, it is able to produce enough torque to begin turning, and through friction with the floor, start rolling and spinning at synchronous speed.

Irregularities. Cast-iron shot are not true spheres, and irregularities may account for some of the more complex gyrations. However, highly accurate steel balls do much the same things.

Gyroscopic effects. If a rolling ball is acted upon by deflecting influences, such as by crossing a field of changing density, or suffering a change of friction with the floor, or in starting to climb the slope of the bowl at the edge of the floor, forces between itself and the floor will induce gyroscopic action. Precession of the axis will lay larger or smaller contact circles into floor contact, linear speed will change, and direction of motion will change. Such behaviors are constantly demonstrated in lesser degree at the billiard table.

Path. The path of a single ball is constantly changing through longer and shorter arcs and whirls. A near-circle may change to elliptical form or to any other simple configuration.

Collisions. There are many collisions when plenty of balls are used. Some of these may result in balls magnetically sticking together, at lower field strengths. Magnetic repulsion tends to reduce collisions.

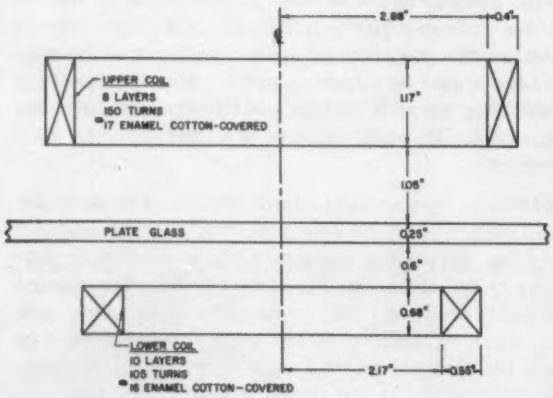

Fig. 2. Data on coils, and vertical spacings used for ball ballet and related demonstrations.

Magnetic repulsion. Unmagnetized balls, placed close together on a horizontal plane, will repel each other when a vertical alternating field is turned on. The repulsion force again is there, even if they are magnetized. Thus, in the ballet, magnetic repulsion plays a prominent part in enabling the balls to avoid collisions. (Electrostatic repulsion may also be present, but this will be described later.)

The Coil Arrangement. It was gradually learned, through much experimentation, that the magnetized shot would put on their best dance in a plastic bowl, if subjected to an alternating field which, first, is vertical or nearly so, and which, second, has a density that decreases somewhat from the center outward.

Both requirements were met by the use of two coils, arranged as shown in Figs. 2 and 3. Plaster posts, Fig. 3, support a glass plate somewhat above the lower coil, and the bowl is set on the plate. Other plaster posts placed on the glass support the upper coil. Spacings are given in Fig. 2.

This two-coil arrangement is reminiscent of the Helmholtz coil design, which might work equally well here. The fact is, these coils are a fortunate compromise. Two unlike coils like these were needed for a development to be described later. After the coils were made, it was found that they also serve the present purpose very well.

Coil Data. Dimensions of the actual windings (not including the coil forms) are given in Fig. 2.

The upper coil has 8 layers, 150 turns, of no. 17 copper, enamel cotton-covered. Its resistance is 1.22 ohms; reactance at 60 cycles, 1.95 ohms; impedance, 2.30 ohms. The lower coil has 10 layers, 105 turns, no. 16 copper, enamel cotton-covered. The resistance is 0.54 ohms; reactance, 0.80 ohms; impedance, 0.96 ohms. Both coils were wound by hand, regularly (not haphazard), and with the layers heavily treated with Glyptal (registered trade mark) varnish as they were put on.

The change of wire size was made for an excellent reason. The writer ran out of no. 17 wire in winding the upper coil.

Connected in series, the two coils have a resistance of 1.76 ohms. When arranged as in Figs. 2 and 3, and *additive,* reactance and impedance are 3.02 and 3.50 ohms, respectively. When arranged as they will be later, resting one on the other except for the glass plate between, the reactance and impedance when coils are *opposed,* are 1.92 and 2.61 ohms, respectively.

The forms were easily made in three pieces. Each cheek is an annulus, cut from hard, stiff pressboard (salvaged from office filing separators). The third piece was a long strip of appropriate width, cut from a manila folder. Scissor cuts were made inward for half an inch from each side, to make ears that would bend over to be cemented to the cheeks with Duco (registered trade mark) cement.

These coils will carry about 4 amperes continuously. Much higher currents are carried for short times. If overheating threatens, a fan can be set up for forced cooling.

Data on the Field. With the coils arranged as in Fig. 2, connected in series with fields additive, a search coil of 20 turns and diameter of 4.25 inches was laid coaxially on the glass plate. Using 10 amperes d-c and a flux-meter, the flux through the search coil was found to be 13,200 lines.

As a check, computation found that the upper coil would put 7,400 lines through this area; and the lower coil, 5,700 lines; the sum being 13,100 lines. Thus, the average flux density at 10 amperes was found to be 930 lines per square inch, or 93 lines per square inch per ampere.

Density variation over the area was investigated by a small search coil. Density at the center turned out to be about 10% higher than the density 1.75 inches away from the center.

The Plastic Bowls. The hard yellow plastic bowls seen in Fig. 3 were purchased at the 5- and 10-cent store at a nickel apiece. The rim diameter is 3.75 inches. Different types or sizes of balls can be assigned, one kind to a bowl, and thus kept separated and identified. Each bowl can be labeled by means of adhesive marking tape.

One of these bowls, selected for smoothness and flatness of the bottom, is reserved for use when the balls are made to dance. Naturally, it is called the "ballroom."

Cast-Iron Shot. Many people who have been shown these phenomena have asked why cast-iron shot is made. It is cheap stuff, made by the ton. Impelled by air blast, it is used for cleaning castings, and for shot-peening surfaces. Quite a range of sizes is available. As it comes, a large fraction of the shot will be fairly round and fairly smooth; but there will be any number of defectives.

The defectives must be largely eliminated, for our purposes. A two-step process was worked out. First, a small batch of raw shot is placed on a large sheet of drawing paper. The paper is picked up by opposite edges, stretched, and shaken slowly, to let the rounds roll down a gentle slope, off the edge, and into a large tray. Many defectives are left behind. This process is repeated several times. The defectives that pass the first step are caught in the second, by visual inspection. A few shot at a time are scattered onto a piece of white paper. Defectives spotted by eye are picked out with a magnetic picker. The picker is a small iron wire, wrapped around the end of a small alnico bar magnet, and extending from the end by an inch or so.

This is hard cast-iron shot we are now considering, which is magnetically retentive. Malleabilized cast-iron shot can also be had, but its retentive quality is much too low for the ball ballet. Thus, the cast-iron shot industry is a cheap source of supply for one who needs small retentive "spheres" by the thousands.

Different Performance with Different Samples. The original dancing-shot discovery was made with the old 1943 sample. A new supply was needed. Industrial Metal Abrasives of Jackson, Mich., kindly supplied a number of generous samples with which to develop magneto-spherics. The Jackson shot put on a good ball ballet, even before the defectives were eliminated. But there was a difference.

Fig. 3. Coils set up for ball ballet, ball crystal, and related phenomena.

The Adrian shot, occasionally, would demonstrate swirls; and very rarely, complete circulation around the ballroom floor. The Jackson shot stubbornly refused to do this. This was a baffling situation. Repeated efforts to make the Adrian shot perform this way, and do it at the will of the operator, met with no success. Either it happened, or it didn't happen. The conclusion seemed to be this: if shot is made in Adrian, it will unpredictably swirl, but if made in Jackson, swirling is out of order. This not being a satisfactory state of affairs, quite a series of experiments was conducted.

Electrospherics Again. These experiments were down the dark alley of no-understanding, and fruitless as well. Nothing worked, until it was recalled that the Adrian shot had been copper-plated. In a mood to try anything, it was decided to copper-plate some of the Jackson shot. There was some improvement, but not much. About this time the idea came, very dimly, that electric charge effects might be needed if the dance were to turn into a swirling or streaming effect.

With that in mind, the next thing was tried: burnishing the rough copper-plating, to smooth the ball surface. The results were spectacular.

Without electrospherics, we can have the ballet; but without electric charge effects, the balls are too prone to collide. Also, at least momentarily, some tend to stick together magnetically. With electrospherics, mutual electrostatic repulsion greatly helps to prevent collisions, each ball then being often able to find a path among its fellows. Streaming can develop. A strongly electrified situation apparently depends on the balls having a smooth surface.

Copper-Plated Shot. The routines for shot preparation as finally worked out are very simple. The selected shot are dumped into a flexible rubber bowl, emery paper is pressed down on the batch and moved around, and the shot are thus cleaned and somewhat smoothed. An acid bath is used to clean them further and to remove oxide. After a rinse, a little water is poured onto the

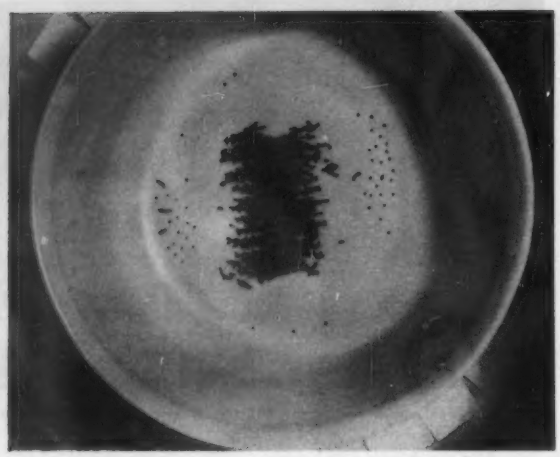

Fig. 4. Mass of size 50 balls (hard cast-iron shot) being magnetized. Magnet is below bowl.

batch, and some powdered copper sulfate is stirred in. The copper at once begins to displace the iron. In a moment or so there is a heavy, but dull copper plating on the shot.

The shot are now dried on a paper towel, and put back into the rubber bowl. The thumb is used to press into the mass of shot and rub the shot against each other. Before wearing out the thumb, the shot will have burnished each other to a bright, shiny finish.

One more note about this process must be entered here. Soon after success was first achieved in this way, and the ball ballet had admirably turned itself into streaming effects, the streaming stopped. Acute frustritis ensued. (Frustritis: disease caused by frustration.) Then it was noted that the ballroom floor had acquired a metallic, coppery sheen. This was acid-removed, and all at once the show was on again. Thus, freshly coppered shot may put a conductive coating on the floor and kill the electrospherics.

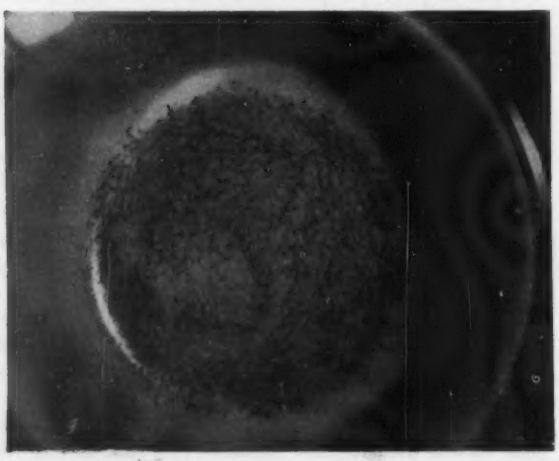

Fig. 5. The ball ballet, in circulation.

Cast-Iron Shot Sizes Investigated. The Jackson shot samples came in three sizes: nos. 110 (smallest), 230, and 390. Each sample exhibits a considerable range in diameter. After selecting, plating, and burnishing, shot from each sample were screened, to separate each into a smaller and a larger group. Visual inspection was then used to pick out those much smaller or much larger than average group size. Six groups were thus secured. Because there is still some size variation within a group, it is perhaps best not to identify these groups with any standard gage system. Therefore, the word "size" is adopted. Size 25, for example, means the average number of balls per inch is 25: a scale was pushed against some of the shot on a flat surface, and those resting against the scale and touching each other were counted over a known length.

The smallest are size 50, having an average diameter of 20 mils. Other sizes, in order, are 44, 32, 27, 22, and 20. All of these do the ball ballet, and all can be made to circulate.

A Cycle of Events. One who opens his own ballroom will soon learn the habits and dancing abilities of his little performers if he repeats, several times, the cycle now to be described. We begin by pouring about one gram of size 50 balls (about 2,500 hardboiled troupers) into the ballroom.

Magnetizing. Two U-shaped alnico magnets are seen in Fig. 3, right foreground. The ballroom is picked up, and a magnet is brought up under it to touch the bottom. Tapping the poles to the bottom two or three times will magnetically mass the balls as in Fig. 4, and magnetize them. The ballroom is put in place, Fig. 3, and the field current is about to be increased from zero.

Minor activity. At 2 amperes, a few dozen balls are dancing, but most of the mass is still intact.

Major activity. At 3 amperes, nearly all have gone into action. Only a small mass remains.

The ball ballet. At 4 amperes, the ballet is in full swing, and audibly so. There is a constant shuffling sound. The activity will be somewhat as the camera has caught it in Fig. 5.

Start of trees. At 6 amperes (watch for coil overheating from here on), a few trees have barely started to grow. Nearly all of the balls are still in action, but with reduced path lengths.

Trees. At 9 to 12 amperes, the forest appears (Fig. 6). Balls are stacked up in peaked groups, or trees. Many singles are sitting around vibrating (fanning themselves?) but going nowhere. The ballet is over.

Demagnetization. This is already accomplished. The strong alternating field acting on stationary balls has largely demagnetized most of them.

Magnetizing. Upon magnetization, the cycle starts all over again. It can be repeated endlessly.

Streaming. The cycle of events did not include the streaming phenomenon, for there were hardly enough balls of size 50 present to induce this effect. We put in more balls, to bring the total to 1.5 or 2 grams. Going up to 4 amperes, we have the ball ballet. If some stream-

ing does not start soon, we back down to about 3 amperes, or just to where a few balls threaten to stop and mass together.

Local streaming, whirls, vortexes. Streaming starts locally, in terms of distinct local whirls or vortexes, each being geared to adjacent vortexes. These look so much like their counterparts in a liquid, that there is a strong illusion of the presence of a liquid.

Circling. In anywhere from a few seconds to a much longer time, one of the eddies seems to predominate, and all-the-way-around circling may ensue, as in Fig. 5. This can be reversed at will, just by grasping the top of the bowl and sharply twisting it the other way. A complete reversal at once takes place.

Interference. If a thin strip of plastic, perhaps an inch wide, is placed with its end on the ballroom floor to block some of the circular flow, eddies will form in front of it and behind it, and other eddies will appear. Again, one has the illusion that he is playing around with a liquid.

Electrospherics. Streaming depends on strong electrification, which holds the balls to the floor, but causes strong mutual repulsion. If, with streaming going on, we breathe into the bowl, the dampness dissipates the charges. All streaming stops, even though the ball ballet continues. It will not resume again until surfaces get dry, and friction again builds up the charges. High humidity will inhibit streaming. When this happens, the bowl can be warmed and dried by holding it close to a light bulb.

Other Shot Sizes: The Ballet and Streaming. It is very interesting to find that irrespective of shot size in the whole range from size 20 to size 50, the phenomena in the cycle of events are duplicated at much the same field currents. Likewise, streaming and circling occur at much the same currents, or field strengths.

However, this is true: the larger the balls, the less the total weight of balls to get successful circulation. Thus, while four or five thousand of size 50 are needed to circle the ballroom floor, only about 50 or so of size 20 will do it.

The larger the ball, the more reluctant it is to be self-starting; for with increase in diameter, the moment of inertia rises faster than the torque on the ball. The larger balls may need some help to get started—to break up the magnetized mass. Banging the ballroom bowl on the plate usually suffices.

Circling: Momentum Constant? The largest shot used, size 20, when circling, circles so fast that most of them tend to race around the edge of the ballroom. It is, therefore, excluded from the following suggestion, which pertains to circling as shown in Fig. 5, with the balls active pretty uniformly over the whole area. Sizes 22, 27, 32, 44, and 50, are included. For them, very roughly, weight of balls to do a good job of circling seems to vary inversely with the ball diameter.

Now, the average speed of a ball should vary directly with the diameter, if it is rolling in a 60-cycle field as a synchronous motor rotor. The total momentum, then, of the circling balls, could be represented by total mass times velocity. If, among different sizes, total mass and velocity vary inversely and directly, respectively, with diameter, it follows that total momentum is constant.

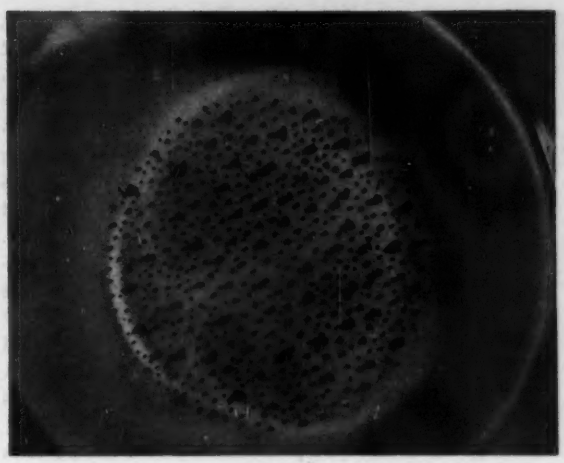

Fig. 6. The forest. Balls are stacked up in pine tree formation by stronger field.

The data at hand are much too rough to serve as proof for this idea; and probably, the untrue cast-iron shot would never yield data trustworthy enough to be taken as proof. This research would require true spheres (adequate quantities of ball bearing balls). But the idea is there, and it might turn out to be true and if so, interesting. Any new phenomenon, such as this business of circling, may be found by someone to be a useful analog for something else; and the constant-momentum concept might become a key factor in the relationship.

Chain Reaction. One or two balls may trigger off the whole assembly. This is done with larger balls, such as size 27. After magnetizing the balls, enough current is used to break up the mass and get all balls into action. The current is then cut off. Many balls are left scattered. Some have magnetically chained up with others. The current is then suddenly raised to perhaps 3 amperes. These larger balls are reluctant to start. But one will begin a path; another, influenced by its approach, starts out; the effect builds up, and very soon, all have gone into action. Here again, interesting and possibly useful analogs may be developed.

Very Small Balls. There is apparently no lower limit to ball diameter, for the ball ballet. Industrial Tectonics Inc. of Ann Arbor, kindly contributed a dozen steel balls, accurately ground and highly polished, of 1/64 inch diameter. Their path behavior is, to their scale of size, like that of larger balls.

Drawing Lines. Those three lines of shot seen in Fig. 7 came from another accidental discovery. The writer, using the magnetic picker described earlier, happened to draw it along the floor among the shot, and was astonished to see a line form! Many others to whom this thing has been demonstrated, have been equally

intrigued. Since the picker is a magnetized iron wire, the first guess was that this was a new magnetospheric phenomenon. Not so. Nonmagnetic wires were tried, and they drew the lines, too.

One way to get good line effects is to carry the ballroom through the cycle of events, ending with the forest, and demagnetization. The balls have now built up electric charges. When the current is cut off, they will stand around as in Fig. 7, mutually repelling each other. Draw a metal wire along the bottom, with light pressure, and the balls form on the line. The lines are extremely durable. Start the cycle over again, start the ball ballet, and erase the lines. Shut off the current, and the lines are still there; the balls reform on the lines. Set the bowl aside until tomorrow, and again, the lines may still be there.

Or again, buy a new plastic bowl, and before it is ever used, draw unseen lines on the floor. Pour in the shot; they show where the lines were drawn. Obviously, then, pressure of the wire has highly electrified the plastic where the wire has touched. Such lines are erasible, simply by using the humid breath from the mouth.

Some things are better "understood" if we do not look too far into them. The trouble here is that if we repeat this thing often enough, parts of a line, or sometimes the whole line, does just the opposite: it *repels* shot that are already charged. And as far as the writer's many experiments have gone, this happens both unpredictably and unaccountably. Someone is needed here who knows more about plastics and their frictional electricity phenomena than is known by the writer or any of his laboratory visitors.

Patchy Effects. Sometimes, either in the ball ballet or in the circling demonstration, patchy effects occur. The balls may crowd to an area, or they may avoid an area.

In view of the line-drawing phenomena just described, it can be seen that when balls are poured into the bowl, extra-high electrification of the surface may occur; and unpredictably, it may be of either sign. When bothersome, patchy effects are erased with the moist breath, and we start with a clean slate.

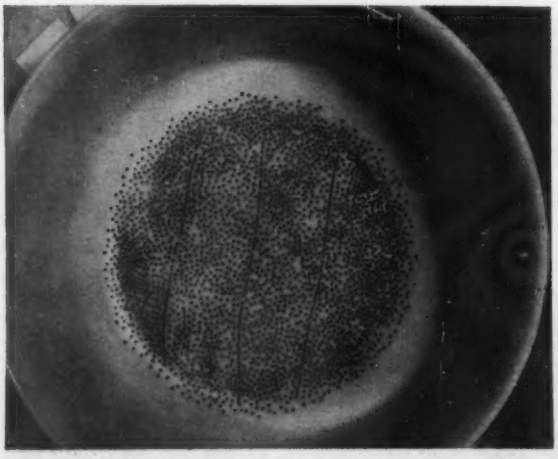

Fig. 7. Electrified lines formed by drawing metal wire along bottom through electrified balls.

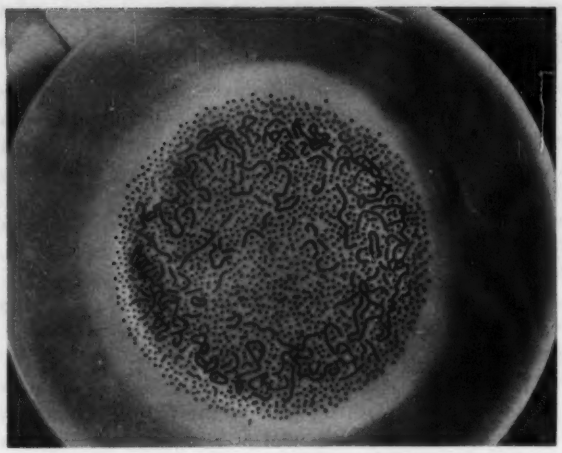

Fig. 8. Chaining-up of magnetized balls at reduced field strength.

Bacterial Chains, Crystal Growth. Some of the most beautiful and fascinating effects of all these phenomena are indicated by the wiggly loops and chains in Fig. 8. Here we start the ball ballet, then ease off on the field current and see what happens. Differing kinds and degrees of magnetic-attraction chaining up of the balls will occur, depending on how fast the current is reduced. The balls, having like charges, repel each other and tend to stay apart. But as reduced ball activity occurs, balls are rolled to positions where the south pole of a ball may catch onto the north pole of another, and a chain or loops begins to form. The degree of magnetization of the balls also plays a large part in what happens, and in the formations achieved.

Thus, we have here a variety of activating causes, one result of which is the formation of some or many chains. It may well be that the viewing of these phenomena as they take place may, in the minds of experts in various fields, help to demonstrate or even explain something about viral and bacterial chains, crystal formation, polymerization, and so on.

The most rewarding sight is to view the dynamic situation. After getting the scene into something like that shown in Fig. 8, we raise the current just enough to have minor activity. One can see the end of a chain waving back and forth. One can see it lose a ball as a near approach or a collision tears it away. One can see a ball make an approach, tend to link on, and miss. Perhaps next, two balls join the end of the chain, and so on, endlessly, and most fascinating.

The Octopus Dance, or Saturday Night at the Beach. This majestic affair is arranged by using a batch of many small balls and adding 25 or 50 much larger balls. At high currents—10 amperes or more—a dozen or so small balls, gather in under a large ball, and hoist it up. The large ball is the head of an octopus, the small balls are

the tentacles. Each octopus slowly moves sidewise, as vibration occurs. Anyone in a despondent mood will profit from viewing this comic spectacle.

Brownian Movement. Nearly all of the engineers and scientists who have witnessed the ball ballet have exclaimed: "Brownian movement!" Actually, since the balls in a particular ballet are all of about the same size and doing about the same things, what they are representing as best they can is, say, the thermal movement of the molecules in a fluid.

If desired, we could chew up a piece of paper to make pulp, then roll bits of pulp into tiny spitballs, and let the spitballs dry. These can have two or three times the diameter of the balls that will activate them. For easy observation, we may use larger balls, such as size 32, and put only two or three hundred balls into action. The spitballs will be erratically kicked around, and give what is perhaps the simplest visual, large-scale demonstration of the Brownian phenomenon. If the spitballs vary considerably in size (as they no doubt will anyway) the demonstration is all the better for it. The smaller the spitball, the greater the movement displayed.

Underwater Ball Ballet. The ballet performs under water, but not as actively as in air. The greater resistance offered by water means that fewer balls will go into action. Also, a ball spinning at synchronous speed may be lubricated by the water and slip more on the floor, causing its linear speed to be less. Thus, the paths that smaller balls, such as size 50, take are much more clearly seen in underwater operation.

Metallic spheres do not like to be wetted. The nuisance is that when we want them to sink, many prefer to ride around on top of the water. Therefore, the writer typically used a wetting agent in the water, to avoid floaters, and make sure that dry shot that did sink would not carry bubbles down with them. At this point, one more happy accident has to be mentioned. Once, in preparing to demonstrate the underwater ballet, the wetting agent was forgotten.

The nuisance appeared: a monolayer raft of shot floated around on the water. The current was raised, things happened, and another line of discovery was opened up.

(This article will be concluded in the March 1959 issue of *Electrical Engineering*.)

Higher Residential Voltages

Safety Considerations

H. H. WATSON
MEMBER AIEE

The comparative safety aspects of the use of potentials higher than the present 120/240-volt level in residences, as covered in an AIEE symposium, are outlined. The discussion includes shock hazards to people and risks of damage to property and equipment from fires of electrical origin.

ADVANTAGES AND BENEFITS of voltages higher than the present 120/240-volt level in single- and multi-family residences have been discussed in AIEE papers and in other documents.[1-18] The comparative safety aspects of the use of potentials substantially higher than the 120/240-volt single-phase 3-wire grounded-neutral level were discussed in considerable detail in 18 conference papers in a symposium at the 1958 AIEE Winter General Meeting in New York City. This article summarizes the 1958 symposium and includes further remarks by the author.

This discussion of safety in the use of electricity is concerned with shock hazards to people and damage to property and equipment from fires having electrical origin. Specifically excluded are the results of lightning discharge or other incidents not related to voltage level, such as the effects of heating caused by overload. The concern here is with electrical distribution systems in residential structures, including the service, service entrance equipment, interior wiring system, and associated wiring devices, enclosures, and connecting devices.

The earliest use of electricity in residences was for lighting. The original installations supplied by central stations were at a direct potential of approximately 100 volts. This value has gradually increased to the present 120-volt a-c level where it is now generally standardized.[19] The original selection of approximately 100 volts was not on a basis of whether 100 volts was a safe value, but was determined by considerations of distribution, the problems encountered in the design of d-c generating equipment, and the properties of the incandescent lamp. It is doubtful that any serious attention at all was given to the selection of voltage level from the viewpoint of hazard. The selection of voltage levels in Europe, which generally are higher than those in the United States, likewise does not appear to have been concerned with safety to man or machine.

The use of electricity in residences at potentials of 120

Revised text of conference paper CP58-1209, requested by the AIEE Safety Committee for the AIEE Fall General Meeting, Pittsburgh, Pa., Oct. 26-31, 1958, as a review of a symposium held at the AIEE Winter General Meeting, New York, N. Y., Feb. 2-7, 1958.

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volts to ground and at 240 volts between ungrounded conductors is not generally looked upon as a hazard by the American public. The potentially lethal effects of 120- and 240-volt rated circuits and equipment are controlled by rigid application of the requirements of the National Electrical Code (NEC)[20] and by widespread use of Underwriters' Laboratories, Inc., listing procedures for electric products. For the higher potentials employed in many other parts of the world, similar controls are in effect to assure reasonable freedom from electrical accidents. It should be understood, therefore, that this examination of the hazards of an increased voltage level in dwellings is not a comparison between one condition which is inherently safe and another condition which might be found to be unsafe. Rather it is a consideration of the probable increase in hazard from a proposed adoption of voltages higher than those now in use.

OPINIONS OF SYMPOSIUM AUTHORS

EIGHTEEN AUTHORS representing various interests in industry participated in the 1958 symposium:

Classification	*Number of Authors*
Utilities	3
Laboratories–Science	3
Codes or Standards	3
Manufacturers	6
Military	2
Maintenance–Repair	1

Classifying general conclusions, in those instances where the authors gave their opinions, under headings pertinent to the specific problem of the safety of higher voltages, the points shown in the following tabulation were established:

Opinion	*Number of Authors*
Higher voltages would be less safe	13
No difference in safety levels between existing voltages and a higher level	4
Added hazard could be provided for by design	11

The opinions here reported do not represent an analysis of a specific proposal for some definite value of voltage, such as in item 2 under "Notes," but rather they are generally directed at a blanket increase in levels to values of from two to four times the present United States practice.

More specifically, the analysis of individual groups of opinion is shown in the following tabulation, which is significant only in that it shows there is no practical consensus either in the area of individual or group interest:

Classification	*Number of Authors*	*Less Safe*	*No Difference*	*Could Be Provided For by Design*
Utilities	3	2	1	3
Laboratories	3	3	0	2
Codes or Standards	3	1	1	2
Manufacturers	6	4	2	3
Military	2	2	0	1
Maintenance–Repair	1	1	0	0
TOTALS		13	4	11

An examination of the individual opinions discloses these further interesting facts:

Utilities. The opinion that no additional hazard would be present was from an ardent Canadian advocate of higher voltages. An equally competent United States utility spokesman did not deny the existence of added hazard. The utility speakers were in exact agreement that the required safety level could be achieved by proper equipment and apparatus design.

Laboratory–Science Groups. These three authorities were emphatic about the existence of an increased hazard but declined to evaluate the increase quantitatively.

Codes or Standards. The disparity of agreement here is explained by the fact that the three representatives spoke respectively for (a) the NEC, (b) the many European equivalents of the NEC, and (c) a specific industry standard, namely, on lighting equipment. These opinions simply reflect existing codes and standards requirements which, by inference, are proved ceilings on safe voltage levels and, hence, if exceeded, are judged to produce unsafe conditions.

Manufacturers. The breakdown of the manufacturers' opinions in detail shows that the speaker whose product would not be affected by an increase in voltage judged the increase not to be an increase in danger, while the speaker whose product would require change or redesign concluded that a higher voltage would constitute increased danger. These opinions must be discounted as valid criteria of absolute safety. It should be noted that this same group collectively only half agreed that design could care for increased hazard—that the degree of danger was absolute and not alterable by preventive mechanics.

Military. The speakers representing two branches of the armed forces were realistic in reporting the attitudes of their organizations based on actual experience which shows the use of higher voltages to include added danger at any voltage level.

Maintenance–Repair. The single speaker here projected his observance of hazard in recorded industrial accidents into the residential area, with emphasis on the growing potential of danger in increased residential use of electricity.

CONCLUSIONS

1. The use of potentials higher than the present 120/240-volt level by a multiplication factor of two will increase the hazards already present in the existing levels but not in numerical ratio to the increase in voltage.

2. Equipment suitable for use at higher line voltage and capable of operation at increased voltage to ground can be designed to include the same measure of safety now prescribed for existing conditions.

3. Portable appliances and lighting should continue to be supplied by 120-volt-to-ground circuits.

4. Potentials of 240 volts to ground should be used only for permanently wired fixed appliances.

5. Many of the unsafe conditions and situations arising from an increase in residential voltages would be transitory in nature. The entire industry and the total population is conditioned to a highly standardized resi-

dential interior wiring system and voltage level. It is to be expected that any breakthrough to a higher voltage level with the appearance of unfamiliar wiring devices, changes in grounding requirements, the presence of circuits requiring new identification and coding, etc., will generate situations giving rise to accidents from causes not now present in the existing system. An evaluation of this hazard cannot be made with any measure of reliability, primarily because in the present system data and statistics are not accurate on a national basis.

6. Some increase in fires would be caused by an increase in voltage as a secondary result of the additional use of grounding to reduce shock hazard. At present voltage levels, some substantial number of fires originate in faults in the grounding arrangements. Because the higher voltages would require an increase in the relative number of grounded appliances it is concluded the fire rate would also increase.

NOTES

1. The speakers at the 1958 Winter General Meeting symposium and their subjects were:

H. B. Whitaker	Underwriters' Laboratories, Inc.	National Electrical Code
R. H. Kaufmann	General Electric Company	Industrial and Commercial Buildings
W. B. Kouwenhoven	Johns Hopkins University	Relative Shock Hazard
L. D. Price	NEMA	European Practices
G. S. Jones, Jr.	Air-Conditioning & Refrigeration Institute	Air-Conditioning Equipment
F. R. Whatmough	CSA Testing Laboratories	Canadian Systems and Appliances
C. G. Veinott	Reliance Electric & Engineering Company	Motors
J. W. St. Andre	Kaiser Aluminum & Chemical Corporation	Maintenance Problems
W. H. Innis (for H. Hyde)	Toronto Hydro-Electric System	Canadian Utilities
E. G. Rudberg	Department of the Army	Army Installations
D. B. Anderson	Underwriters' Laboratories, Inc.	Underwriters' Laboratories Requirements
C. D. Friday	Department of the Navy	Navy Installations
T. C. Duncan	Consolidated Edison Company	Utility Distribution
J. E. Goff	Ceil Heat, Inc.	Space Heating
H. I. Stanback	Square D Company	Panelboards
H. E. Campbell (for P. F. O'Neill)	General Electric Company	Heat Pump
A. S. Anderson	Ebasco Services, Inc.	Residential Service
G. A. Freeman	Westinghouse Electric Corporation	Lighting Sources

2. At this time (July 1958) the most actively supported proposal for high-voltage circuits appears to be the use of 240/480-volt single-phase 3-wire secondary circuits operating at 240 volts to ground. The service to any individual residential structure would consist of a 2-wire 240-volt single-phase circuit grounded at the service entrance as at present. The fixed high-energy appliances—water heater, range, wall-mounted oven, countermounted cooking unit, clothes dryer, and heating and cooling equipment—would be supplied at 240 volts to ground over 2-wire appliance branch circuits. Convenience outlets for portables and outlets for lighting would be served by 120-volt 2-wire 120-volt-to-ground circuits originating in an autotransformer connected to the 240-volt supply.

3. Existing feeder and branch circuit overcurrent protective devices would have to be re-evaluated for use on the higher voltage secondary utility supply. Plug fuses are rated at 125 volts maximum.

4. Although it is generally a violation of local codes or ordinances for any person other than a licensed or competent mechanic to alter the permanent wiring in a residence, it is well known that homeowners in very substantial numbers, as well as members of other than the electrical trades, do make additions, extensions, and repairs to wiring. For this reason, the proposed new higher voltage circuits would have to be segregated and distinctively identified from the 120-volt circuits. This requirement perhaps would necessitate the use of separate distribution boards for each system.

5. The National Electrical Code and its many local or state derivatives would require major changes to give requirements appropriate to a new voltage level.

6. Those Underwriters' Laboratories Standards applicable to equipment to be operated at or connected to higher voltage circuits would have to be revised. Certain materials, notably insulated wire and cable, are now rated at 600 volts, but requirements for identification of higher voltage circuits might necessitate a new series of identification means.

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Electrical Features of the Eddystone Station

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THE ELECTRICAL FEATURES of the Philadelphia Electric Company's 650-mw Eddystone Station are noteworthy because of the problems created by the use of supercritical pressure turbine–generators, and because of the complexities of integrating this large block of power into the existing system. Reliable and economical solutions of these and associated operating problems were given primary consideration in the execution of all phases of the project, from the planning stages through engineering, design, and construction.

There will be two supercritical-pressure cross-compound units, each rated 325 mw, 416 mva at 20 kv. The stators and rotors of the first unit will be inner-cooled with hydrogen at 45 pounds pressure. The second unit generators will have conventional cooling with hydrogen at 30 pounds.

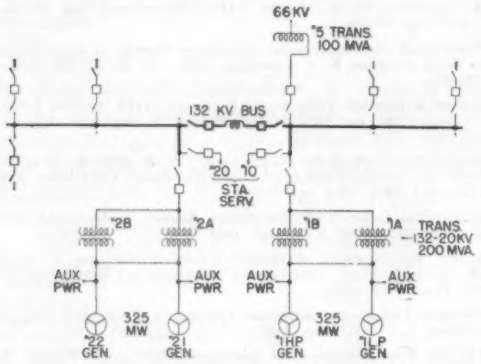

Fig. 1. Eddystone Station, one-line diagram.

Simplicity is carried out in the unit system as shown in Fig. 1. The two generators of each unit are connected directly to a pair of transformers with a total nominal rating of 400 mva. The transformers are paralleled on both low- and high-voltage sides and connected through a circuit breaker to a separate 132-kv bus section. The coolers are separated from the transformers and mounted in two groups between the transformers, with the two groups interconnected by piping. Normally, each transformer operates with its own coolers. Should it become necessary to remove one transformer from service, manual operation of the valves will connect the coolers of this transformer to the remaining transformer to permit full nominal output of the highly efficient generation.

The auxiliary power requirements are of the order of 28 mva for unit 1 and 26 mva for unit 2. In addition, there are two 5,000-hp turbine-driven high-pressure boiler feed pumps per unit. The auxiliary power system is basically a simple 4-kv radial system and follows the unit principle. Two 12–16-mva 20/4-kv OA/FA (oil-immersed, self-cooled/forced-air-cooled) unit auxiliary power transformers are solidly connected to the generator leads for the supply to essential unit auxiliaries. The power for starting the main units and for emergencies is supplied through a two-section station service bus by two 15–20-mva 138/4-kv OA/FA station service transformers, and these transformers are each supplied through a circuit breaker from a separate 132-kv bus section. The largest motors are 4,500 hp, and the motors 300 hp and above are supplied at 4 kv. Motors below 300 hp are supplied at 440 volts with a few exceptions, primarily for reasons of location.

Feeds to the auxiliaries are distributed among the busses so that any one of the boiler auxiliary busses, the screen basin busses or the source feeder can be lost without shutting down the main unit; therefore, no automatic transfer scheme is used.

In the 132-kv substation, aluminum conductors are used for all busses and taps. The supporting structures for all equipment and busses are of welded-aluminum construction, having a first cost which is about the same as that of conventional copper and steel construction, but a maintenance cost which is considerably less.

As a result of extensive studies, provision to avoid instability has been included by the use of dual relay protection to clear phase faults in the shortest possible time.

An extensive transmission plan requiring 100 miles of new lines was precipitated by Eddystone, but general load growth and system reinforcement are largely responsible for much of the required transmission. To avoid the high cost of underground cable construction, extensive use is made of railroad rights of way and 2/3 of the additional line mileage is on such rights of way.

Another measure of the size and complexity of the project is that it requires 19 major transformers with a total capacity of 2,300 mva. The use of autotransformers wherever feasible and reduced insulation levels results in substantial cost savings.

The high efficiency of supercritical pressure turbine–generators of this size is a compelling reason to attain maximum availability factor, thus dictating a high degree of reliability of the electrical features. On the other hand, cost must be held to a minimum. It is believed that the optimum balance between these two basic requirements has been achieved by stressing simplicity.

Digest of paper 58-576, recommended by the AIEE Power Generation Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Middle Eastern District Meeting, Washington, D. C., Apr. 28-30, 1958. Published in AIEE *Power Apparatus and Systems*, Oct. 1958, pp. 707-13.

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Drying and Rehabilitating Distribution Transformers

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A LARGE INDUSTRIAL PLANT on the eastern seaboard has developed a method of drying and rehabilitating transformers used in its electric power distribution system in its own shops. The procedure does not require a drying oven and produces results which equal or excel oven-drying in time requirements and improvement of insulation-resistance values. Development of this process was made necessary by the fact that the plant was faced with the prospect of failure of several 5,000-kva 11.5- and 2.3-kv transformers, which would have seriously crippled operations, and which readily could have resulted in complete shutdown of the plant for an extended period.

This plant has a total of 87,250 kva in 11.5–2.3-kv transformer capacity, with individual units ranging from 750 to 6,000 kva in size. Thirteen 3,750/5,000 kva transformers, totaling 65,000 kva, constitute the most important part of the total capacity. It was in this group that failures occurred.

It is the belief of the author that industrial-type loads impose more severe operating conditions on air-breathing transformers than utility-type loads, in those industries which operate on a 5-day workweek. Transformers carry no load or such light loads over the week ends that they cool to air temperature, drawing in more air and accompanying water vapor than utility system transformers, which are seldom without load and which have shorter periods of light load. These conditions can be shown to result in a greater accumulation of free water in the bottom of the transformer tank. Loading the transformer rapidly to a substantial part of its rating when operations are resumed produces a vigorous circulation of oil, which may carry a slug of free water up into current-carrying parts, causing internal flashover and failure.

Five such failures occurred in two years, each following two or more days of practically zero-load operation and each failure occurring after about four hours of loading at about the self-cooled rating of the transformer. Each failure started in the lowermost point of an outside 2,300-volt coil, burned through the winding insulation to the high-voltage coil, starting an 11.5-kv phase-to-ground fault. Ground relay operation tripped the 11.5-kv breaker, isolating the fault.

Prior to the first two failures, transformers had been inspected visually and the water-traps on the conservator tanks drained each week. Oil was tested for breakdown strength at approximately quarterly intervals. Acidity determinations were not made routinely but a test of all transformers in 1948 had shown all oil to be below 0.10 neutralization number. Tests after first two failures showed neutralization numbers from 0.20 to 0.60. Field treatment with fuller's-earth filters resulted in producing oil samples of satisfactory breakdown and acidity, but did not remove contamination from oil which did not pass through the filter, nor from the winding insulation. Investigation showed all other transformers of this class in danger of failure, the prevention of which required untanking, cleaning, drying, and replacing of oil in each transformer.

No local shop was equipped to do this work, so the repair of the units on which failures had occurred had to be made in out-of-town shops. The time for rail shipment and the work load on these shops' facilities indicated that too long a time would be required to have the transformers rehabilitated by others. Plans were started to construct an oven and to procure the other equipment needed to do the required work. The fire hazard inherent in oven drying oil-soaked insulation ruled out doing such work in the power plant where adequate space and rail and crane service existed, and where the work could be easily supervised. Lack of personnel experienced in this work also was a factor which made oven drying questionable.

A study of the fundamental requirements for moisture removal led to the belief that transformers could be dried in a satisfactory time and manner by circulating hot oil at a safe temperature and applying sufficient vacuum to reduce the vaporizing temperature of water to a point below the oil temperature. Equipment was available to try this process immediately on a transformer which had shown such low readings that it had been removed from service to prevent failure. After cleaning, the experimental setup raised the insulation resistance from values of 5 megohms for high-voltage winding to core, 1.5 megohms for low-voltage winding to core, and 6 megohms for high- to low-voltage winding to 290, 49, and 330 megohms respectively, corrected to same temperature, in 34 days of operation. Heavy tarpaulins, which had been used to reduce heat loss, and other improvised items of equipment were replaced as the drying program progressed. All transformers with critically low insulation values have been successfully cleaned and dried without further failures. Laboratory tests show that oil is not damaged by continued circulation at the temperature used.

It is believed that the method developed produces results equal to or better than oven drying, without fire hazard, and that by its use the time and expense of transporting transformers to an oven-equipped shop can be eliminated.

Digest of paper 58-565, "Field Drying and Rehabilitation of Large Distribution Transformers," recommended by the AIEE Transformers Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Middle Eastern District Meeting, Washington, D. C., Apr. 28-30, 1958. Published in AIEE *Power Apparatus and Systems*, Oct. 1958, pp. 749-55.

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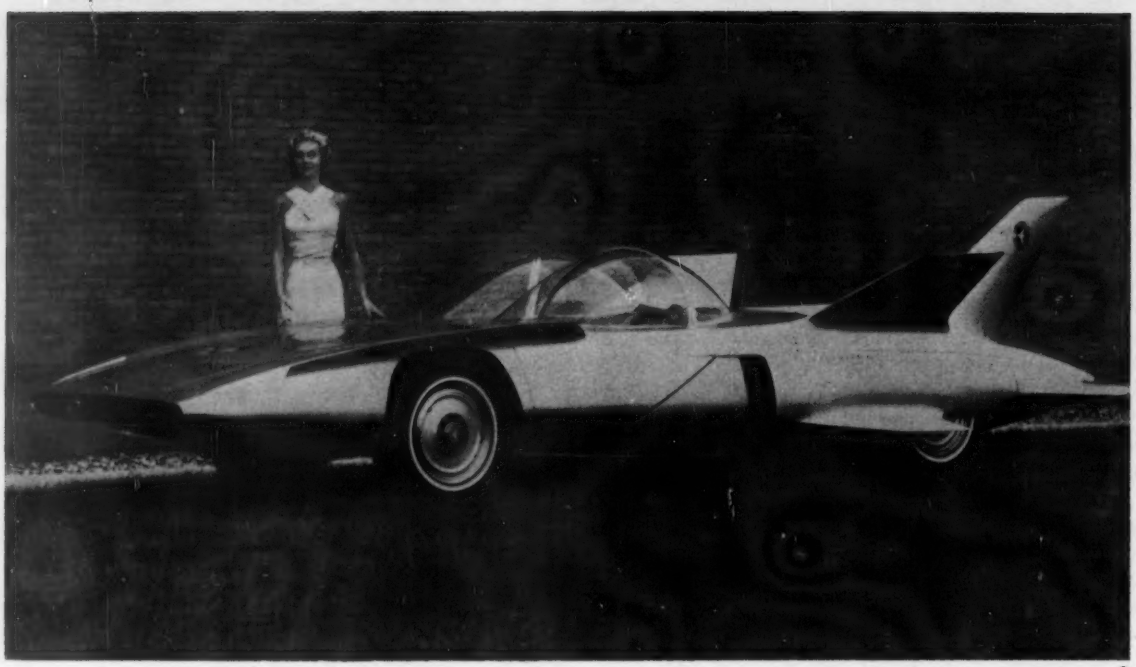


A

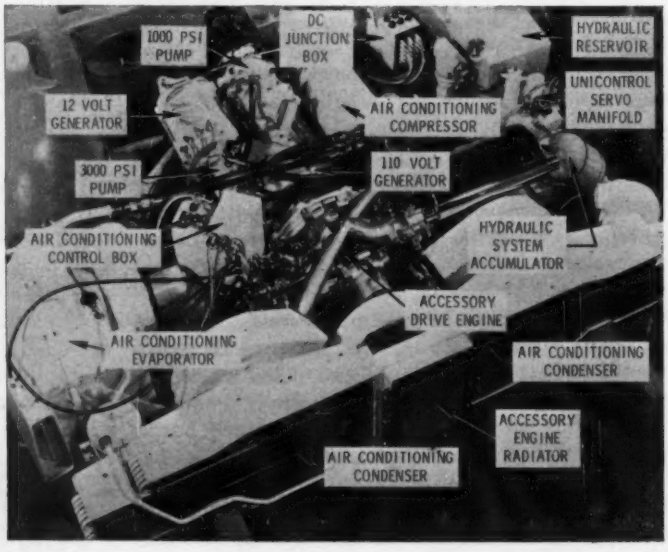
Automotive Design Uses Aircraft Methods

FIREBIRD III, the first vehicle to be controlled entirely by electronics *(picture A at top of this page)* is driven with a single fingertip control unit which governs steering, throttle, and brake through analog computers and electrohydraulic servomechanisms *(Electrical Engineering,* "Improved Safe Highway Travel," June 1958, p. 571). This is the General Motors Corporation's (GM) experimental gas-turbine automobile which was demonstrated to those persons who attended the Special Committee on Highway Safety meeting during the Governors Conference held April 10-12, 1958.

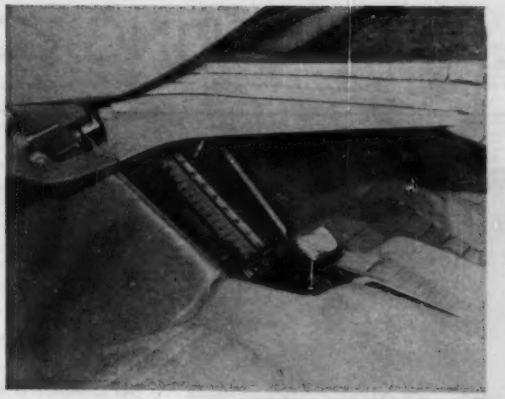
Pushing a button cuts Autoguide into the Unicontrol

B

C



system *(picture* ***D*** *top of this page)* in order to steer the automobile electronically along a road-embedded electrical cable *(Electrical Engineering,* "Nebraska Pioneers Electronic Vehicle Control," February 1958, p. 200; *Ibid.,* "Electronic Highway of Tomorrow in Operation," July 1958, p. 654). The steering computer mechanism receives its signals from a pair of tuned pick-up coils beneath the car *(photograph* ***F*** *lower right-hand side of this page),* rather than from the Unicontrol stick that takes the place of a conventional steering wheel.



D

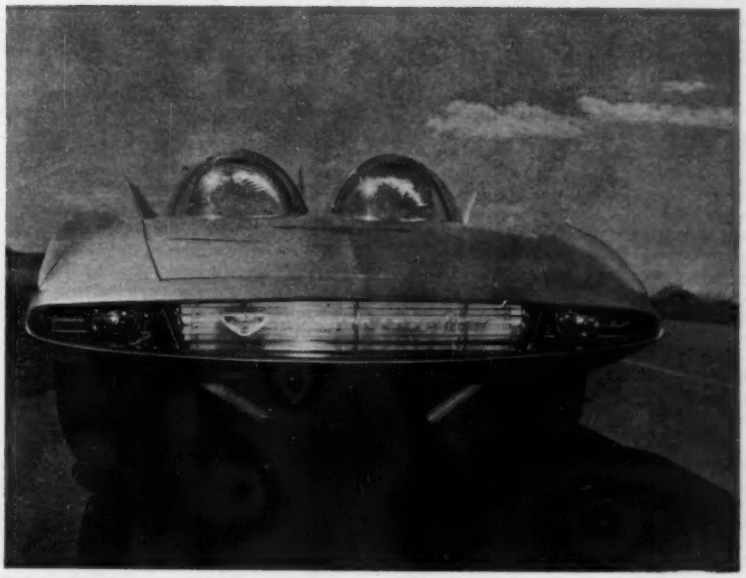
E

At the touch of another button, Cruisecontrol takes over the throttle and then automatically maintains whatever road speed has been set on its dial.

An auxiliary piston engine which is located in the nose of this missile-like vehicle powers all of the accessories *(pictures* ***B*** *&* ***C*** *bottom of preceding page).* This includes the 12-volt as well as the 60-cycle 110-volt a-c generators in the automobile. Its constant-speed drive has made possible the devolopment of extremely compact and light-weight units that have appreciably higher efficiencies than formerly.

The nerve center for this unique automobile's revolutionary control system and some 40 boxes of electronics is a special relay control panel that is mounted just ahead of the rear wheel *(photograph* ***E*** *center left-hand side of this page).* Routing all power through this panel greatly simplifies trouble shooting the Firebird III's electronically controlled heating and airconditioning system, ultrasonically operated doors, electronic horn, two-way radio, and many other electronic gadgets. It also makes possible remote radio control of some 32 of the automobile's functions thus facilitating the stage display of this futuristic automobile. Firebird III is the first completely electronically controlled car built. It was designed and built by automotive men who quite deliberately studied aircraft techniques They do not intend to take to the air with this vehicle. But they feel that the lifting of previous limitations imposed on conventional automotive design will serve to bring to the consumer better cars in the future. It is felt that as the airplane progressed from manual to electronic control, so may the auto.

F



ELECTRICAL ENGINEERING EDUCATION

AIEE in the University of Michigan

THE OFFICERS of the Student Branch at the University of Michigan are: Chairman J. S. Squire, Vice-Chairman D. E. Atkinson, Activities Chairman D. M. Yee, IRE (Institute of Radio Engineers) Secretary H. W. Estry, AIEE Secretary J. T. Olson, and Treasurer F. L. Miller. Academic Counselor is Prof. J. G. Tarboux.

Activities of the Student Branch include a luncheon every Wednesday during the academic year at which there is a special speaker or presentation of a movie. Monthly, a meeting is held featuring an outside speaker. The Wednesday luncheons draw some 30 persons, while the AIEE–IRE combined membership is about 100.

The program in electrical engineering at the University emphasizes basic theory and provides the student with a broad and fundamental background. A student may achieve, however, by careful selection of elective courses, a measure of specialization even within the basic undergraduate program. Extensive specialization should be reserved for graduate study.

The Engineering Arch (left) is one of the best-known University landmarks and is at one end of the diagonal walk located on the original 40-acre campus.

Courses in engineering have been offered at the University continuously since 1853.

Grid-Current Measurements with a D-C Analog Computer

J. R. COX
STUDENT MEMBER AIEE

INCREASED USE of amplifiers at frequencies of 0 to 20 cycles per second has focused attention on the problem of designing direct-coupled amplifiers. Grid current, in particular, is a problem, inasmuch as it causes a change in tube bias that cannot be distinguished from a signal. For this reason, direct-coupled amplifiers are designed to operate in the region where grid current is normally considered negligible. Operation in this region, however, is not in itself a solution because even these small currents are significant in direct-coupled amplifiers. Since grid-current characteristics for this region are not included in handbooks, the designer must solve the new problem of measuring these currents.

The values of current that must be measured usually extend from a few micromicroamperes to several microamperes and are beyond the range of ordinary measuring devices. These currents have been measured at the A&M College of Texas during the past year by use of d-c analog computer elements, but the method has not previously been analyzed in detail. The purpose here is to supply a detailed analysis.

Grid-Current Characteristics

A typical curve of grid current in the region of direct-coupled amplifier operation is shown in Fig. 1. Scales have been placed on the axes to give an order of magnitude for grid currents. The curves will vary widely between tube types and even between individual tubes of the same type. The grid-current scale has been changed at the voltage axis in order to show more of the curve.

The negative component of current results from positive ions in the imperfect vacuum of the tube. This current, therefore, is affected by the number of ions present as well as by the grid potential. The density of the gas in the tube and the velocity of the electrons accelerated by the plate are important determinants of the number of ions present. Gas in the tube

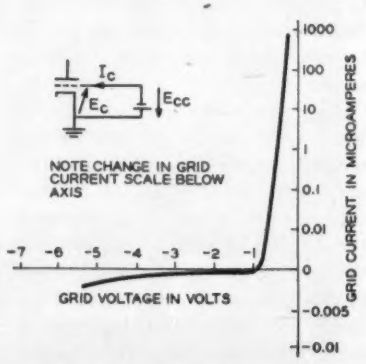


Fig. 1. Grid-current curve.

Full text of the paper awarded first prize in the AIEE District 7 Student Prize Paper Competition. Recommended for publication by the AIEE Educational Publications Committee.

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may also be ionized to some extent by light or other external radiation.

The positive component of grid current, on the other hand, is more nearly a direct function of the grid voltage. It represents the flow of electrons from the cathode to the grid. Some of the electrons emitted by the cathode have an initial velocity of such direction and magnitude that they strike the grid even though it may be somewhat negative. This explains the positive currents at negative grid potential. The curve of Fig. 1 continues to rise sharply as the grid becomes positive and begins to attract electrons.

The zero grid-current point represents a balance of these positive and negative components of current. Similarly, the curve for some distance on either side of this point shows the resultant of the two components of current rather than the effect of one or the other.

Grid-Current Measurement

The circuit of Fig. 2 has been used to measure currents as low as a few hundred micromicroamperes. Fundamentally, the tube conditions are held constant by the amplifier while the capacitor integrates the grid current. Then, from measurements of the rate of change of capacitor voltage, the grid current can be determined.

Principle of Measurement. The operation of the circuit of Fig. 2 can be understood by a consideration of the interdependence of plate voltage, plate current, and grid voltage of the tube. If the value of any two of these three variables is fixed, the third must be a value consistent with the tube characteristics. In this circuit, plate voltage is fixed by the setting of the potential divider R_d. The plate current will be constant at the value required for zero amplifier input. It will be shown that, as a result of the action of the amplifier, this is the only value of plate current that can exist under steady-state conditions.

To show that tube conditions are constant, the circuit will first be considered with the switch S_1 closed. The −400-volt power supply has been shown as a battery for simplicity. Kirchhoff's voltage law applied to the grid circuit yields

$$E_i + E_c - E_o = 0 \tag{1}$$

The equation for amplifier output is

$$E_o = -AE_i \tag{2}$$

where A is the magnitude of gain. When this value of E_o is substituted into equation 1, it gives

$$E_c = E_i\,(-A - 1). \tag{3}$$

Since the magnitude of the gain A is very high (approximately 10,000),

$$A \gg 1 \tag{4}$$

then

$$E_c = -AE_i \tag{5}$$

to a very close approximation.

For the loop containing E_i and R_k,

$$E_i + 400 \text{ volts} = V \tag{6}$$

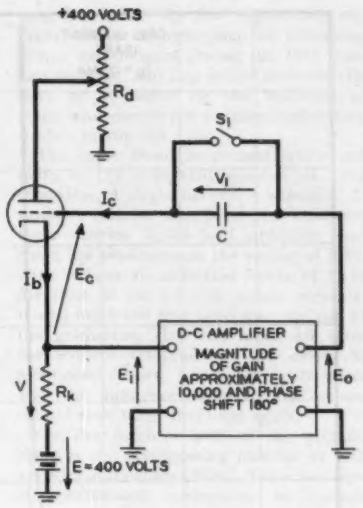

Fig. 2. Basic circuit for measuring grid current.

Since the amplifier has a very high input impedance,

$$V = I_bR_k \tag{7}$$

and equation 6 becomes

$$E_i = I_bR_k - 400 \text{ volts} \tag{8}$$

Equation 8 shows that E_i can be zero* if I_b is of the proper value. If I_b were to increase slightly from this value E_i would have a slightly positive value. By equation 5, this positive E_i would be reflected as a very large negative change in E_c. The plate current would therefore decrease, bringing E_i back to zero. If E_i were to become negative, it would be corrected to zero in a similar way. Obviously, the only stable condition is that in which the current I_b is of the proper value to make E_i zero. With both I_b and E_b fixed, E_c must stabilize at a voltage consistent with the characteristics of the tube.

When switch S_1 is opened, the grid current will cause a voltage to build up across the capacitor. Equation 5 now becomes

$$E_c = -AE_i - V_1 \tag{9}$$

This equation indicates that E_i will change by an amount

$$\Delta E_i = -\frac{V_1}{A} \tag{10}$$

when the switch is opened. The capacitor voltage V_1 can change only with grid current, and with the proper choice of capacitor size it need not exceed several volts. Its effect on the condition of constant plate current, therefore, can be neglected.

Method of Measurement. By equations 2 and 5,

$$E_o = E_c \tag{11}$$

when switch S_1 is closed. This value of E_o is the first measurement made. Plate voltage may be adjusted until the value of E_o indicates the grid voltage at which current is to be measured. When the switch is opened,

$$V_1 = \frac{1}{C}\int I_c\,dt \tag{12}$$

Because the tube conditions are constant, I_c is also a constant and the equation may be written

$$V_1 = \frac{I_c}{C}\,\Delta T \tag{13}$$

Also, from equations 2 and 10,

$$\Delta E_o = V_1 \tag{14}$$

Substitution of the value of V_1 in equation 13 shows the grid current to be

$$I_c = C\frac{\Delta E_o}{\Delta T} \tag{15}$$

With ΔE_o in volts, ΔT in seconds, and C in microfarads, this equation yields I_c in microamperes. The usual procedure is to let E_c change until ΔE_o is an amount that allows accurate measurement. This change is timed with a stop watch.

The method of measurement must be modified slightly for grid currents in the microampere range. For available values of precision capacitors, the capacitor voltage change with this much current is too rapid for accurate measurement. These currents can be measured if a precision resistor is substituted for the capacitor. Then, the voltage V_1 is the I_cR drop in the resistor and it can be measured at the amplifier output in the same way capacitor voltage was measured. This method could be used at lower currents if precision resistors of sufficient magnitude were available.

Advantages of the Method. Measurements of low grid currents with the circuit described are not difficult. Changes from one test point to the next are made simply by adjustment of plate voltage, and if a digital voltmeter and stop watch are used, there is little reading error. The accuracy, therefore, depends almost entirely on the equipment.

An advantage is gained by making measurements at the output of the amplifier. The amplifier has a low output impedance and should be able to deliver several milliamperes. These characteristics allow the use of a laboratory d-c voltmeter, rather than a less accurate vacuum-tube voltmeter, if a digital voltmeter is not available.

* Actually E_i will differ from zero by $-E_c/A$. This value is negligible by the same approximation made for equation 5.

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Equipment Used

The d-c analog computer at Texas A&M is especially useful for measuring grid-current characteristics. It provides d-c and a-c power, d-c amplifiers, precision resistors and capacitors, and a digital voltmeter.

Utility Panel. To facilitate measurements even more, a utility panel was designed for the computer. The panel, shown in Fig. 3, provides voltage supply busses, extra busses, ground busses, several type of tube sockets, clips for attaching resistors and capacitors, and three potentiometers. All busses, tube socket terminals, clips, and potentiometers are connected to banana jacks on the panel. Banana plug leads are used on the computer boards and, therefore, are readily available. It is also easy to connect computer elements into the circuit with these leads. The resistor clips allow most circuits to be connected without soldering.

Amplifier. The amplifier used in the circuit must be a d-c amplifier with high gain, 180 degrees phase shift, and small drift. In addition, it is necessary that the input impedance be high and the output impedance be low. D-c analog computer amplifiers fit these qualifications very well. They are single-stage positive-feedback amplifiers that attain a gain of about −10,000. A cathode follower is added to provide low output impedance. Chopper stabilization can be added to prevent drift.

Digital Voltmeter. When the capacitor method of measurement is used, an instantaneous reading of a changing voltage is needed. The digital voltmeter, which is a self-adjusting potentiometer, lends itself particularly well to such a measurement. It is accurate to the last of its four digits if the reference voltages are sufficiently accurate. Thus far, no permanent reference voltages have been provided for the digital voltmeter in the computer at Texas A&M. Initial condition voltages with isolation amplifiers are used. They are reasonably accurate as references, if they are calibrated frequently.

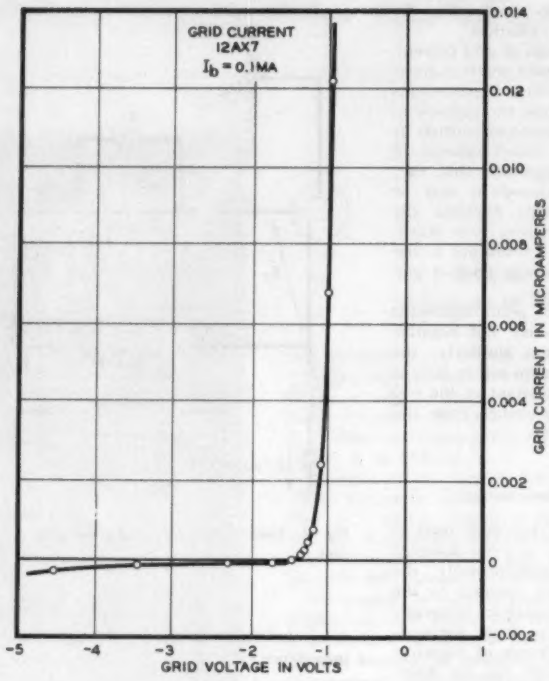

Fig. 4. Example of a grid-current curve.

Accuracy

The grid-current curve example in Fig. 4 was obtained by the method described. The fact that all the points lie on a smooth curve indicates the precision of the measurements. This precision is not unusual, but is found in almost all of the curves that have been taken. Therefore, the accuracy, as noted before, is limited only by the equipment. The curves taken with the Texas A&M computer are probably within 5% accuracy, which is sufficient for most purposes because the grid-current characteristics change somewhat with age of the tube, temperature, and other conditions.

Conclusions

Measurement of grid currents with magnitudes below the range of ordinary measuring devices is necessary for the design of direct-coupled amplifiers. The circuit described furnishes a simple and accurate means of measuring these currents. Although it is designed for use with d-c analog computer elements, other readily available or easily constructed components could be used.

A detailed analysis of the accuracy of measurements should be made. It should include the effects of capacitor leakage, capacitor dielectric polarization, switch leakage, magnitude and phase shift of amplifier gain, and environmental conditions.

Some of the principles used in these measurements could be applied to other measurements. For example, grid-current curves made with the method described are for constant plate current. By varying the cathode resistor, curves at constant plate voltage could be obtained.

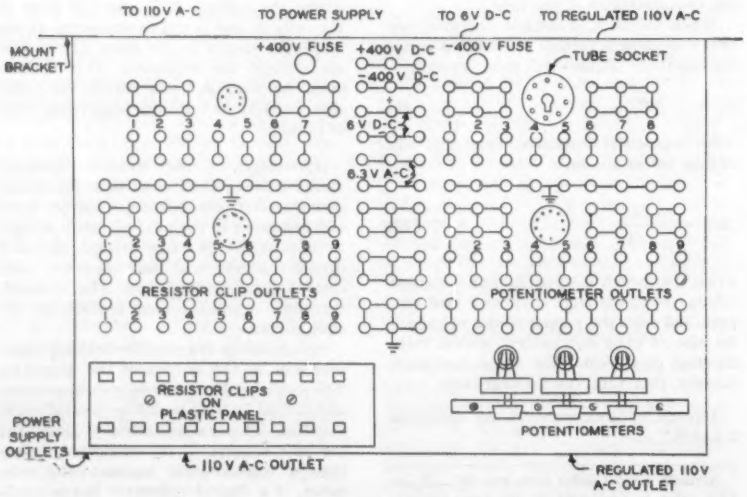

Fig. 3. Utility panel.

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2. Vacuum-Tube Amplifiers (book), G. E. Valley, H. Wallman. Radiation Laboratory Series, Massachusetts Institute of Technology, McGraw-Hill Book Company, Inc., New York, N. Y., vol. 18, 1948, pp. 418-21.

EIC Publishes "Engineering Careers in Canada"

The 1958-59 edition of "Engineering Careers in Canada" was recently issued by the Engineering Institute of Canada (EIC).

Published as a service to engineering students and their potential employers, the booklet is intended to facilitate contact between young graduate engineers and firms requiring engineering personnel, and to aid students in selecting their courses.

These goals are met in the publication by presenting short surveys of the various fields in which engineers are needed such as aircraft, chemical industry, communications, electrical power, mining, nuclear engineering, pulp and paper, teaching and research at universities, and others. Also included are announcements by various companies of employment opportunities for young engineers.

Over 12,000 copies of this publication have been distributed to the students, libraries, and other vocational information agencies in Canada and in neighboring countries.

Engineering Registration at Canadian Universities

The Engineering Institute of Canada (EIC) has released the results of its annual survey of engineering registration at Canadian universities and colleges. The tabulations were prepared from lists obtained direct from the university registrars, and they were compiled at EIC Headquarters in Montreal, Que.

The survey will be interpreted in different ways, according to varying points of view, but certain facts stand out which are worthy of special comment.

Perhaps the most important figure to examine is the grand total of the enrollment. This now stands at 14,552 as compared with 14,247 a year ago. This increase, slightly over 2%, is the smallest rise to be reported for quite a few years. Different causes for this could be sought, but it is not considered to be too significant for the reason that new and improved university facilities on many campuses are expected to swell the total again soon.

Observers of these trends are always interested in the statistics of new freshman intakes. The recent survey discloses a sharp drop in the number of new engineering students starting their courses in 1958. The total new class numbers 4,572 against 5,132 in 1957, a decrease of 11%. This does not reflect a very healthy condition. At least in part, it must be attributed to general economic conditions during the year. One effect was that engineering students had a difficult time in obtaining proper employment during the 1958 summer vacation, and this would undoubtedly have an influence on the decisions of many who considered starting engineering studies in the fall.

The same trend is evident when one looks at the estimated number of 1959 graduates. A slight decline is expected. If students now in their final year complete their courses, 2,104 will graduate and enter the profession in the spring of 1959. This follows an estimated figure of 2,130 for 1958. If the forecast proves accurate, it will mark the first time that the size of the graduating class has fallen off since the student veterans left the scene. As mentioned before, new teaching facilities and the influence of oncoming classes should soon boost this total again.

On the brighter side of the picture, there is the ever-growing number of universities and colleges listed. There are now 30 educational institutions in Canada where some kind of an engineering course is offered, and 15 of these now grant degrees. It is interesting to watch the continued rapid growth of engineering education in western Canada. The recent survey has disclosed that 30% of students now enrolled in engineering are taking their courses west of the Lakehead.

An examination of the results in the different faculties shows a steadily increasing interest in the study of engineering physics, as commented on in 1957. Total enrollment in this branch now stands at 727 which is an increase of 12½% over 1957. The Sputnik age is certainly having its effect on young minds in their choice of studies.

Electrical Engineering Education

An Electrical Engineer in Industry

W. A. DEL MAR (AM '06, F '20, Member for Life), consulting engineer, Habirshaw Cable & Wire Division, Phelps Dodge Copper Products Corporation, Yonkers, N. Y.

"For the past 55 years, my field has been electric cables, first as an engineer to users and then to a manufacturer. With every succeeding year, I learn how much more there is to learn. I have written quite a bit on the subject of cables, including a couple of books, long since out of print, but I was once asked 'what on earth can you say about an inert thing like a cable, to fill up two books?'

"I answered that there are innumerable problems, both theoretical and practical that enter into their design, manufacture, and operation which require as much knowledge of physics, chemistry, mechanics, and mathematics as the field of electronics, which seems to attract so many eager young men today. The AIEE has afforded a wonderful opportunity to discuss these problems with others having similar interests, both at meetings and in committee. Cable sessions of the AIEE are always well attended and discussions have to be cut off before everyone has had his say.

"There is no Institute committee to compare with that on Insulated Conductors for activity, keenness of interest, and number of problems studied.

"However, I do not remember any of my professors having mentioned a cable in the course of my training as an engineer at the City & Guild College of London, where I graduated in 1900. But what is more important is that most professors of the present day, I am told, are equally silent. Maybe they don't know how much they don't know about the subject."

Mr. Del Mar was born in San Francisco, Calif., on December 15, 1880. His early engineering experience included service with the General Electric Company, Manhattan Railway Company, New York Central Railroad Company, and Interborough Rapid Transit Company. He joined the Habirshaw Electric Cable Company in 1918.

An active member of the Institute, Mr. Del Mar has served on numerous AIEE Committees including: Headquarters (1918-22, chairman 1920-22); Board of Examiners (1920-22); Publication (1919-21); Research (1920-28); Safety Codes (1914-15); Standards (1914-50); Traction and Transportation (1917-19); Executive (1921-22); Transmission and Distribution (1921-29, 1945-47); Instruments and Measurements (1925-26); Protective Devices (1924-25); Library Board of United Engineering Trustees (1929-44); Lamme Medal (1944-47); Insulated Conductors (1947-59). He served on the U. S. National Committee of the International Electrotechnical Commission (1919-32).

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Midwest Work Course on Materials Handling Analysis

The second annual Midwest Work Course on Materials Handling Analysis is scheduled to be held in Kansas City, Kans., starting February 2, 1959. The intensive five-day study program is sponsored by the Kansas City Center of University of Kansas Extension.

This integrated and highly practical course is planned specifically for materials handling analysts, industrial engineers, and others already experienced in materials handling planning who are looking for the latest in techniques and procedures of materials handling analysis.

The course features discussions under the leadership of recognized authorities. They include I. M. Footlik, D. W. Pennock, D. O. Haynes, and E. A. Carlson, with Richard Muther as technical director. Mr. Muther brings to the 1959 course fresh insights gained from a recent trip to Europe where he conducted two full half-day sessions at the International Materials Handling Course in Delft, The Netherlands.

The 8-hour daytime schedule of regular work–study sessions is supplemented by after-dinner meetings to allow enrollees to present specific problems to the staff of specialists.

For full details, contact the administrative director: E. S. Avison, University of Kansas Extension Center, 39th & Rainbow Blvd., Kansas City 12, Kans.

U. S. Delegation Reports on Engineering Education in the USSR

ENGINEERING EDUCATION of sound quality is effectively integrated into the planned economy of the USSR.

This was one of the major observations of the 8-man mission of United States engineering educators who returned recently from 3 weeks of study and inspection in the USSR.

Among their observations, members of the mission called attention to the dynamic character of Soviet engineering education, the continuous process of reevaluation affecting it, and the ability of this controlled system to adjust to the inevitable variations in personal capabilities at both the student and faculty level.

The mission was sponsored by the American Society for Engineering Education (ASEE) and the National Science Foundation (NSF) with the co-operation of Engineers' Council for Professional Development (ECPD). Its chairman was Dr. F. C. Lindvall (F '43), chairman of the Division of Engineering at California Institute of Technology; Prof. N. A. Hall, head of the department of mechanical engineering at Yale University, was secretary.

Other members were:

W. T. Alexander, dean of engineering at Northeastern University, Boston, Mass., president of the ASEE.

Dr. W. L. Everitt (F '36), dean of engineering at the University of Illinois, president of ECPD.

Prof. R. E. Fadum, head of the department of civil engineering at North Carolina State College.

Dr. A. G. Guy, professor of metallurgical engineering at Purdue University.

Dr. R. A. Morgen, director of the Purdue Research Foundation.

Dr. Leon Trilling, associate professor of aeronautical engineering at the Massachusetts Institute of Technology.

This mission was initiated by the Department of State under an agreement with the USSR for the exchange of scientific and cultural delegations. A comparable Soviet educational mission is expected to visit the United States in February 1959.

Members of the United States delegation visited 25 teaching and research institutions in Moscow, Leningrad, Kuibyshev, and Frunze. The last is the capital of the Kirgiz Soviet Socialist Republic, situated on the border of China some 2,100 miles southeast of Moscow. This city was of particular interest because its engineering school is new, growing rapidly, and planned to meet the particular needs of an expanding industrial and agricultural economy.

Preliminary Report

According to the preliminary report of members of the mission, the whole economy of the USSR is integrated into a broad plan administered by an agency known as GOSPLAN. The formulation of the portion of the master plan related to engineering education is the responsibility of the Ministry of Higher Education.

A long-range plan covering a period normally of 5 years (currently, 7 years) is formulated first. Each year this master plan is modified to take into account the accomplishments actually achieved in the previous year. The plan considers the needs of the whole Soviet Union in the light of: (a) the expansion of industrial plant capacity, (b) the need for replacements, and (c) the replacement by professional people of nonprofessional personnel not adequately trained.

The 7-year plan now being formulated contemplates that an average of 350,000 graduates in all professional fields (engineering, science, medicine, languages, etc.) will complete their training each year. This is an increase of 40% over the average of the past 7 years, but in engineering it is proposed that the increase shall be 90%.

The master plan specifies: (a) the number who may enter the institutions of higher education, (b) the number who may train for each field of specialization, (c) the quota of each specific institution for each specialty, and (d) the jobs which will be available at the time of graduation.

Such planning demands that each student (at present upon graduation from the 10-year school at the age of 17 or 18) must choose irrevocably a narrow field of specialization when he applies for admission to college. Alternatively, he may postpone this decision by temporarily entering industry; under changes now contemplated, this period of industrial experience may become obligatory. The rules allow the student to apply for only one field of specialization in one institute in a given year. Furthermore, he commits himself to work in the particular phase of industry for which the course is designed. If he fails to secure admission in a severe competition (but one which varies in its severity with the field and institution), he may not apply for higher education for another year.

While the student makes a commitment as to his field, the goals and objectives of the plan may be changed by the state from time to time. Thus, specific curricula at certain schools may be eliminated. The students then enrolled in such curricula will be shifted to a similar specialty in which additional manpower is needed. They may, however, be allowed additional time, up to six months, to adjust to the change.

As indicated in the foregoing, changes in the program are now under consideration. These include: (a) revision of the amount of industrial practice required, (b) broadening of the base of some curricula, and (c) changing the number of students in specialties to fit the revised industrial program.

It is understood that the secondary school program is also undergoing critical analysis with a view to making extensive changes, but the delegation did not have the time or opportunity to study this.

Since Soviet engineering education is planned to fulfill the specific needs of the state, it is tailored in considerable detail to the jobs to which the young engineer will go upon graduation. The curricula are narrowly specialized in their objectives and prepare the students to be immediately useful to industry with a minimum of additional training. This results in dividing engineering into some 160 separate specialties such as mechanical engineer–automobile designer or mechanical engineer–automobile maintenance. This contrasts sharply with less than 20 fields accredited in the United States, of which the great majority of students are included in about five fields.

The duration of the full-time day program is 5 or 5½ years. The first 2 years are broadly based on mathematics and science. But from the day of his matriculation the student pursues a specialty. For the most part, he meets in lectures

or laboratories only with other students taking the same program. The illustrations in mathematics, physics, chemistry, mechanics, etc., are selected to emphasize their application to his field.

The last 3 years consist of increasingly specific courses, often built around design projects, industrial practice, and an elaborate diploma project requiring one semester of full-time work. These projects involve extensive detailed drawing and are intended to acquaint the student both with principles and prevailing practice in his specialty.

The young Soviet engineers are well grounded, and their best men are as good as any in the world. However, it appears to the delegation that many must be limited in their outlook by knowing little engineering outside their own narrow field.

Position of the Engineer

Nowhere is the engineer and scientist held in higher regard than in the USSR. Engineering students and practicing engineers are exempt from military service. Indeed, engineers and scientists are among the aristocracy of Soviet society. There is, therefore, strong motivation and social pressure to aspire to such careers.

An engineering education opens the door to positions of high rank. On the other hand, to achieve such positions without some type of diploma would appear virtually impossible. In general, the limit of achievement of the nongraduate in an industrial enterprise is the position of foreman, while this is considered the minimum position for a graduate.

A motivation factor not to be underestimated is the strong devotion to a system that greatly encourages education. Those who qualify for admission to an institution of higher learning need not be concerned because of a lack of financial resources. Grants are provided by the state in sufficient amount to care for basic needs.

A system that offers such unique advantages to the educated instills a strong desire for higher education in the youth of both sexes. Currently about one third of the total enrollment in the schools of engineering technology is comprised of girls. Competition for admission is keen. The planned economy provides one opportunity for every three to nine applicants, depending on the prestige of the institution and the importance attached to the specialty. Since students may make only one application for admission in a given year, the less able are motivated to apply for admission to a specialty in which there is a minimum of competition rather than to the specialty of their first choice.

As a result of these factors, a seriousness of purpose pervades the classroom and laboratory. This is clearly evident to the most casual observer. The students themselves have a genuine respect for intellectual achievement and disdain for the laggard. For example, we saw cartoons on bulletin boards drawn by students to scold those who do poorly in their work. We also saw a statue of a student studying his lesson on the way to class and were told that poor students are hazed by their fellows before this symbol. In this atmosphere, approximately 90% of those who gain admission to the day schools complete diploma requirements and 50% of those in evening and correspondence programs graduate.

We also observed that the educational system is able to adapt itself not only to changing industrial needs but also to the wide ranges in human interest and ability. The system recognizes the tendency of the most able people in intellectual fields to make their best contributions when associated with others of comparable attainment and in an environment quite largely of their own choosing. It was observed that able people in the USSR prefer to work in the larger cities and the older institutions, where cultural and intellectual activities are most widely available. Hence, the strongest faculties were found to be associated with educational institutions in these centers. Although the detailed program for a given specialization is the same for a large number of institutions offering that specialization, the Ministry of Higher Education recognizes that the level at which these topics will be taught must depend upon the background and ability of the professors.

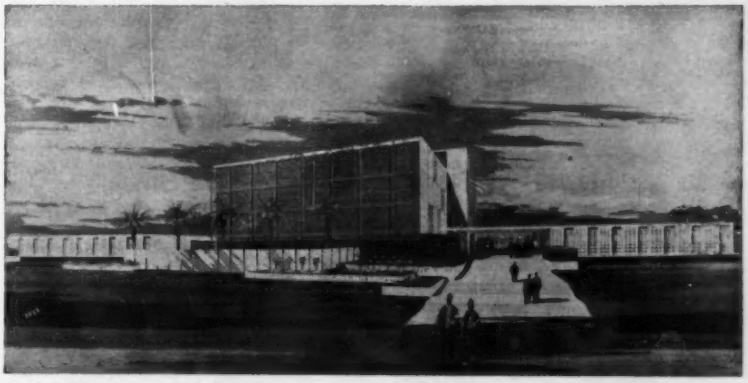
Outstanding Institutions

Some 14 outstanding institutions offer more advanced and individualized curricula. These institutions are given greater freedom in changing their curricula from the prescribed pattern. Modifications of appreciable magnitude are usually approved by the Ministry with little delay. These institutions, as well as the stronger industrial groups and research institutes, are expected to provide leadership in changing programs to meet new scientific and engineering developments. It also appears that competition to enter these institutions is keener and that they attract the most able students from all over the Soviet Union.

For several years there has been much expressed difference of opinion in the United States concerning the quality of technological education in the USSR. This mission has had the opportunity to observe classes in operation, to talk with teachers and to examine curricula. It is clearly evident that thorough, scientifically based programs of study are in operation.

Laboratory equipment is of good quality and in ample supply but varies appreciably between institutions. In addition, considerable imagination has been used in developing equipment to demonstrate basic principles. Textbooks appear to be in ample supply and carefully prepared. They are encyclopedic in nature and include much practical information in addition to the theory. Furthermore, an extensive background in mathematics is required to follow accurately much of the text material. It appears that the entering student knows as much mathematics and somewhat more physics and chemistry than college freshmen entering the better engineering schools in the United States. The Soviet 5- and 5½-year curricula afford time to give a good theoretical background in addition to much practice with problems specifically related to the student's specialty. However, the members of the Mission agree that engineering education in the USSR cannot be compared

UM School of Engineering Building



MODERN LABORATORIES, computing rooms, and classrooms will be available in September 1959 for students in the University of Miami (UM) School of Engineering when the J. Neville McArthur Building is scheduled for completion. Donor for whom the building is named is a pioneer Florida dairyman, civic leader, and UM trustee. Ground was broken November 13, 1958, on the million dollar building located on the main UM campus. Some 12 laboratories and dozens of classroom and offices will be housed in the school's 5-story center section and two 2-story wings. Architects are Wahl Snyder & Associates of Miami, Fla.

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realistically with that in the United States because it is tailored to quite a different system.

Reception of U.S. Delegation

The delegation was accorded every courtesy by the Ministry of Higher Education and by the faculties of the institutions that were visited. Competent interpreters were made available, who also became friends. Transportation facilities were on hand whenever needed—from Leningrad to Frunze, a range of 2,500 miles.

A genuine spirit of friendliness prevailed in the discussions of educational matters, which were free and uninhibited. Much interest in developments in United States education was manifested and a strong desire was indicated for participation in exchange missions to the United States.

Aid To Stimulate Science Study Shown

A unique new teaching aid designed to meet in part the critical need for stimulating science interest in the schools was given its first public showing recently at the National Academy of Sciences (NAS) in Washington, D. C.

Known as "Planet Earth," the new aid covers the scientific fields studied during the International Geophysical Year (IGY). It has three major components. The first includes six large full-color posters entitled "The Earth," "The Oceans," "The Poles," "Sun and Earth," "Weather and Climate," and "Space."

The second component is a profusely illustrated 44-page Student Brochure which reproduces the posters and describes the work of scientists in a dozen or more fields. The third component is a Teacher's Kit containing suggestions for classroom experiments, background material on aspects of the IGY and the earth sciences, a description of teaching methods related to the IGY in the Baltimore County schools, a list of scholarships available to students in the field of science, and other materials.

"Planet Earth" was conceived by the NAS as a first and partial answer to the rapid increase in scientific interest among young people which was touched off by the IGY. An avalanche of inquiries about the IGY from students and teachers convinced the NAS that the schools needed a teaching aid to complement their textbooks, to stimulate the imagination of students, and to provide new information in the fields of geophysics where great new strides are being made.

"Planet Earth" was prepared under the direction of Dr. Hugh Odishaw, executive director of the U. S. National Committee for IGY, with the assistance of leading designers and artists. An Advisory Committee of distinguished scientists and educators, appointed by NAS President Dr. D. W. Bronk, assisted in shaping the project. Financial support was provided by the National Science Foundation (NSF) and the Ford Foundation. The NAS was also guided in the early stages of the project by advice and assistance from Dr. Ellsworth Oburn, U. S. Office of Education; Dr. Robert Carleton, executive secretary, National Science Teachers Association; and officials of the NSF. The final materials were exhaustively reviewed by distinguished scientists engaged in the U.S.–IGY program.

The posters have been designed so as to combine a wealth of technical detail with visual appeal. The NAS also wished them to convey the interrelationships of scientific disciplines and the unity of man's knowledge. Each poster uses a symbolic or mythologic figure to suggest man's ancient wonder about his world, establishes a theme by quoting a line of appropriate verse, and conveys a sense of personal adventure in scientific work over the globe.

After a year in preparation, "Planet Earth" is now ready for distribution to the schools. The package and its components are priced at cost. A classroom package—6 posters, 30 Student Brochures, and a Teacher's Kit—is priced at $9.50. Distribution is through the National Academy of Sciences Publications Office, Washington, D. C.

Northeastern University Marks Engineering Anniversary

Northeastern University marked the 10th anniversary of its graduate program in engineering in the fall of 1958 with a record enrollment of more than 1,500 students.

The Engineering Division of the Graduate School had its start in 1948 with a handful of students enrolled in six advanced courses on an exploratory basis. After the initial offerings, the response became so enthusiastic it was clear a new need was being met that hadn't been served before.

Northeastern became the only New England institution offering master of science degrees in engineering through evening study and today still remains unique in this respect.

Under the direction of Dean E. A. Gramstorff, the Graduate School of Engineering has continually expanded its curricula offerings and enrollment. Currently, a student may pursue a graduate engineering degree in civil engineering, mechanical engineering, electrical engineering, engineering management, chemistry, mathematics–physics, and communications.

A relatively new development in the program is the addition of the Co-operative Plan of Education. Under this plan, students alternate 16-week periods in evening classes with equal periods working on regular paying jobs in business and industry. Open to students majoring in civil, mechanical, or electrical engineering only, the program is a minimum of two years.

Dean Gramstorff indicated that in the past many working engineers enrolled in specific graduate courses to increase their knowledge in isolated areas.

"Now many engineers see the value of following advanced degree programs to their completion, eliminating the occasional specialized course in favor of studying for the master of science degree," he said.

Each year, since its inception, the Graduate Program has experienced new additions to the course offerings and the enrollment has continually expanded.

In the fall of 1959, the school will experience another change—it will have a new spacious and modern headquarters in the University's $1.5 million Graduate Center, scheduled for completion this coming summer.

Campus Conferences

Midwest Industrial Radioisotopes Conference. The U. S. Atomic Energy Commission and Kansas State College are joint sponsors of a Midwest Industrial Radioisotopes Conference, to be held February 25-26, 1959, on the campus of Kansas State College. The participating states are: Kansas, Colorado, Nebraska, Arkansas, Missouri, Oklahoma, Iowa, South Dakota, and Wyoming. Program and registration details are available from John Kitchens, Department of Continuing Education, Kansas State College, Manhattan, Kans.

Computer and Data Processing in Industry Conference. The object of this conference, to be held February 12-13, 1959, at Purdue University, will be to acquaint middle and top management with computers and data processing. The following will be covered: (1) basic concepts of computers and data processing, (2) the application of computers for answering management questions, (3) new developments in the field, and (4) "case examples" showing how computers and data processing can be used in industry. Further information may be obtained from Prof. J. H. Greene, Department of Industrial Engineering, Purdue University, Lafayette, Ind.

Report Available on Engineering Research at NYU

Total research expenditures at the New York University (NYU) College of Engineering continued at the $3 million level, according to the 1958 annual report of the College's Research Division, which was published recently. Among the sources of support were private industry, Government agencies, foundations, professional societies, and the research funds of the College.

The Division's program consisted of a wide range of projects in both basic and

applied research. Many of these were concerned with the national defense and with problems of public health and sanitation.

The research was conducted by 461 faculty members, full-time research engineers and scientists, and graduate students. These included not only representatives of the traditional engineering sciences but also meteorologists, nuclear engineers, physical therapists, biochemists, statisticians, solar energy scientists, and industrial engineers.

"A striking advance in interdisciplinary research was begun this year," Dr. H. K. Work, director of the Division, states in the report. He describes a project being carried on at New York University and at Stevens Institute of Technology under the sponsorship of the Committee on Ship Structural Design of the National Academy of Sciences.

The project is concerned with the development of a long-range research program for the improvement of ship structural design. Involved will be four departments at NYU—aeronautical engineering, meteorology and oceanography, mechanical engineering, and engineering mathematics—and various departments at Stevens Institute of Technology.

Among the companies, societies, and foundations that sponsored research at the NYU College of Engineering in the past year are the American Chemical Society, the Arabian American Oil Company, Consolidated Edison Company, the Control Instrument Company, the Dow Chemical Company, the General Dynamics Corporation, the General Electric Company, the Lincoln Laboratories of the Massachusetts Institute of Technology, Merck & Company, the National Lead Company, the Olin Mathieson Chemical Company, and the Sperry Gyroscope Company.

Governmental sponsors included the military agencies of the Federal Government, the Veterans Administration, the U. S. Public Health Service, the National Advisory Committee for Aeronautics, the Atomic Energy Commission, the Department of the Interior, the Tennessee Valley Authority, the National Institutes of Health, the New York State Department of Health, and the New York City Board of Water Supply.

The 44-page illustrated report can be obtained from the Office of Information Services, New York University, University Heights, New York 53, N. Y.

Section Meets with AIEE Student Branch

The first joint meeting of the Illinois Valley Section of the AIEE and the newly organized Bradley University AIEE Student Branch was held December 4, 1958, in Jobst Hall on the Bradley University Campus.

Principal speaker at the meeting was H. D. Else, consulting engineer, Westinghouse Electric Corporation, whose subject was "Electric Generators for Flight Vehicles." His presentation covered the development of aircraft electrical equipment from the period prior to World War II to the present. He also commented on some of the possibilities for obtaining power in space flight.

R. B. Gear, AIEE vice-president for District No. 5, attended the meeting as guest of the Illinois Valley Section.

Appointments and Awards, Engineering and Science Faculty

California Institute of Technology, Pasadena. Dr. Louis Weinberg, head of the communications and networks research section of electronics laboratories at Hughes Aircraft Company, has been reappointed visiting professor of electrical engineering by Caltech.

Rutgers University, New Brunswick, N. J. Dr. M. L. Granstrom, formerly an associate professor at the University of North Carolina, has been named chairman of the department of civil engineering in Rutgers College of Engineering.

University of Michigan, Ann Arbor. A. R. Hellwarth, formerly with The Detroit Edison Company, has been appointed associate professor of engineering and secretary and assistant dean of the University of Michigan College of Engineering.

University of Wisconsin, Madison. Staff members added to the faculty of the University of Wisconsin's College of Engineering are: Dr. Miklos Hetenyi, visiting professor, and Dr. W. S. Clouser and Dr. M. W. Johnson, both assistant professors, all in engineering mechanics; Dr. M. W. Carbon, professor, and W. A. Moy, assistant professor, both in mechanical engineering; Dr. F. H. Vitovec, associate professor of metallurgy; Dr. E. J. Crosby, assistant professor of chemical engineering; and Dr. Donald Dietmeyer, assistant professor of electrical engineering.

University of Arizona, Tucson. Dr. G. M. Nordby, head of the department of civil engineering at the University of Arizona, has been appointed to the Engineers Joint Council Committee on Engineering Sciences.

Hobart Brothers Technical School, Troy, Ohio. H. B. Cary, formerly with the Marion Power Shovel Company, has been appointed director of the Hobart Brothers Technical School, established in 1958 by the Hobart Brothers Company of Troy as a nonprofit school devoted to teaching, research, and development in the welding field.

International Correspondence Schools, Scranton, Pa. J. A. Risse has been named director of the School of Electrical Communications, International Correspondence Schools.

Princeton University, Princeton, N. J. Dr. E. P. Wigner, renowned authority in theoretical physics and Thomas D. Jones Professor of Mathematical Physics at Princeton University, has been named to receive the Atomic Energy Commission's Enrico Fermi Award "... for contributions to nuclear and theoretical physics, to nuclear reactor development, and to practical applications of atomic energy."

Harvard University, Cambridge, Mass. Two scientists in Harvard's Division of Engineering and Appled Physics have been named to receive awards from the Institute of Radio Engineers (IRE). The IRE Medal of Honor goes to E. L. Chaffee, Rumford Professor of Physics and Gordon McKay, Professor of Applied Physics, Emeritus. The Morris Liebmann Memorial Prize will go jointly to Harvard's Nicholaas Bloembergen, Gordon McKay

Electrical Engineering Education

Courtesy Peoria Journal Star

AT THE FIRST JOINT MEETING of the AIEE Illinois Valley Section and the Bradley University Student Branch were *(left to right)*: R. B. Gear, AIEE vice-president for District No. 5; H. D. Else of Lima, Ohio, consulting engineer, Westinghouse Electric Corporation, principal speaker; Tom West, chairman of the Bradley University AIEE Student Branch; and C. E. Crawford, chairman of the Illinois Valley Section.

Electrical Engineering Education

Professor of Applied Physics, and Columbia University's Professor C. H. Townes, for their contributions to the development of the maser.

Booklet Describes Career Opportunities

The opportunities offered by industry to young people interested in choosing a career in electrical engineering are described by D. C. Switzer, construction manager, the Hartford Electric Light Co., Hartford, Conn., in a unique publication that has achieved universal text book status in Connecticut.

The chapter on electrical engineering is one of 27 articles on industrial vocations in this booklet, which is entitled "Planning Your Future in Connecticut Industry." The booklet is distributed to secondary schools by the State's four major electric utilities as an educational and public relations undertaking. It is used in over 90% of the State's secondary schools, primarily in guidance instruction.

Covered in each article are: schooling, major duties, personality requirements, and advancement possibilities in each field. The author of each analysis is a person who has attained success in his or her particular field.

More than 170,000 copies have been distributed to Connecticut's high schools in the past 5 years. This year's edition is revised, with format and contents updated to give a current view of each field.

The career booklet is sponsored by the Connecticut Light and Power Company, the Hartford Electric Light Company, the Housatonic Public Service Company, and the United Illuminating Company.

Traffic Engineering Fellowships Available at Yale

The Bureau of Highway Traffic at Yale University has announced the availability of fellowships for the 1959-60 academic year to be awarded to qualified graduate engineers who are citizens of the United States and would like to enter the profession of traffic engineering as a career.

The fellowships cover a full academic year of graduate study, starting in September 1959 and terminating the following May. They provide a living stipend of $1,400 disbursed at the rate of $175 per month for a period of eight months, while a student is enrolled. The fellowships also provide the tuition of $800, which amounts to a total value of $2,200 for each fellowship. The fellowships are made available to the Bureau through grants from the Automotive Safety Foundation, the Esso Safety Foundation, the Liberty Mutual Insurance Company, and The James S. Kemper Foundation.

The Bureau also offers tuition scholarships to qualified municipal and state highway engineers who will receive financial aid from their employers while undertaking the graduate work. This arrangement is considered by many employers to be a form of in-service training.

The Bureau has trained 479 men. Most of these graduates hold responsible traffic engineering positions in city government and state highway departments as well as commercial agencies. The academic year of traffic engineering study consists of two full semesters of classroom work, laboratory and individual research, required reading, field problems, and seminars. The courses include (1) traffic characteristics and measurements, (2) traffic regulations and control devices, (3) highway planning, (4) highway location and geometric design, and (5) highway administration and finance. Traffic experts from all over the country are invited to speak as guest lecturers at frequent intervals.

Applications for admission and further information may be obtained by writing to F. W. Hurd, Director, Bureau of Highway Traffic, Yale University, Strathcona Hall, New Haven, Conn. Fellowships and scholarships are awarded to those applicants with highest qualifications. The closing date for filing applications is March 1,1959. Previous experience in traffic work is not essential to become a successful candidate for a fellowship or scholarship when other qualifications are indicated.

Duke Plans Annual Engineers Show

The Duke University College of Engineering will conduct its 27th Annual Engineers Show, "Engineering in Action," on March 20-21, 1959.

The show, which will feature student projects, demonstrations, and exhibits in every aspect of modern engineering science, will attract visitors from all over the southeastern United States. Last year the exposition drew more than 9,000 guests to the Duke campus during its 2-day span, making it the largest local attraction during the spring semester.

Specific details can be obtained by writing to T. R. Taylor, c/o College of Engineering, Duke University, Durham, N. C.

NYU Courses in Electronic Technology

Six evening courses in electronic technology will be offered during the spring semester by the New York University (NYU) Division of General Education, Dean P. A. McGhee has announced.

The noncredit courses, the times they will be given, and their instructors are:

Elements of Electrical Theory (A-C and D-C)—Mondys, 6:15 to 8 p.m., from February 2 to May 25, A. J. Falcone of the Consolidated Edison Company.

Elements of Radio Tubes and Circuits—Mondays and Thursdays, 6:15 to 8 p.m., from February 2 to May 25, Morris Groder of the Control Instrument Company.

Radio Tubes and Circuits II—Thursdays, 8:10 to 9:55 p.m., from February 5 to May 21, Morris Groder.

Transistor Applications in Modern Electronics—Mondays, 8:10 to 9:55 p.m., from February 2 to May 25, Marvin Meth, member of the faculty of the City College of New York

Automatic Control Systems—Wednesdays, 6:15 to 8 p.m., from February 4 to May 20, Raymond Pickholtz of the International Telephone & Telegraph Company.

UHF and Microwave Communication Systems—Wednesdays, 8:10 to 9:55 p.m., February 4 to May 20, I. D. Baumel of the Crosby Laboratories.

Further information on the electronic technology courses can be obtained by writing to the Division of General Education, 1 Washington Square N., New York 3, N. Y.

ASEE Stresses Importance of Two-Year Technical Institutes

Two-year technical institutes, which provide a unique educational opportunity for young people to prepare for positions in support of professional scientists and engineers, are a vital part of American higher education, according to the American Society for Engineering Education (ASEE).

"Wide recognition of this type of higher education, as distinguished from 4-year engineering courses and from vocational programs," the ASEE says, "is important for the future welfare of the Nation—both in the interest of national defense and in developing a national economy."

The ASEE statement came from its General Council and Executive Board at recent meetings called to consider how the United States may use her present resources to supplement professional scientists and engineers, now in short supply for many vital projects.

Following the meetings, the ASEE wrote Dr. L. G. Derthick, U. S. Commissioner of Education, "It is our understanding that funds are available under the National Defense Education Act of 1958 for training men and women for useful employment as highly skilled technicians in recognized occupations requiring scientific knowledge. We hope that the law will be administered in such a way as to support the established plan of technical institute education in America, which needs expansion to meet current and future engineering manpower requirements." Narrow, vocational training will not provide the support which today's scientists and engineers require, the ASEE said.

"Most of the engineering educators who have been close to the development of technical institute education during the past decade," says Dean K. L. Holderman, of the Pennsylvania State University, chair-

man of ASEE's Technical Institute Division, "recognize that the need in American industry today is for engineering technicians who are prepared to work as aids to professional engineers. Their education and training can best be directed by those with engineering experience. There is a difference between vocational training and education for semiprofessional employment; legislators and the general public must be so informed."

As of 1956, according to an ASEE Survey of Technical Institute Education, there was a total of 121 institutions offering technical institute curricula, reporting 11,091 graduates and an enrollment of 49,968.

The published report of this ASEE study, due for completion early in 1959, is expected to call for a substantial increase in this type of education. "We have a confirmed need for qualified and properly prepared technicians in engineering," according to G R. Henninger, president of the Ohio Mechanics Institute, who is director of the ASEE project, "which exceeds by several times the much-talked-about need for scientists and engineers."

"One of the most productive ways to increase our effective supply of professional scientists and engineers is through integrated development of engineering technicians," he says.

New Computer for IIT Campus

A new electronic computing system, the Univac *1105*, will be installed on the campus of the Illinois Institute of Technology (IIT) in the spring of 1959.

Chicago gains one of the nation's most advanced computing and data processing facilities by this expansion of Technology Center's problem-solving capabilities, according to Dr. J. T. Rettaliata, IIT president.

The model *1105* computer, a Remington Rand product, is the first designed to handle efficiently all digital computer applications encountered in business and science, said H. H. Kantner, supervisor of mathematical services at IIT's Armour Research Foundation, which will operate the Univac *1105*.

Developed from Remington Rand's *1103-A*, the new model has outstanding capabilities for the solution of scientific, engineering, and management problems. Additionally, its design makes it exceptionally well-suited for the data processing tasks of commerce and industry, Mr. Kantner said.

Housing encompassing 5,000 square feet of floor space at the Armour Research Foundation has been allotted to the extremely large, fast, and versatile computing system.

Explaining the planned utilization of the giant computer, Mr. Kantner indicated that the primary uses of the Univac *1105* will relate to IIT's educational and research activities, Armour Research Foundation's industrial and Governmental research projects, and a continuing program of assistance to the U.S. Department of Commerce, Bureau of the Census, for the processing of data such as that to be obtained in the Decennial Census of 1960.

The census work will be part of an over-all plan whereby anticipated peak work loads can be accommodated on compatible computer installations committed to this purpose in advance.

Acquisition of the combined scientific-business computer and its planned utilization for substantial data processing as well as engineering and scientific applications emphasizes the growing interdependence of commerce and scientific research and the increasing influence of mathematical methods. The Armour Research Foundation's unified facility for research and services in the sciences of mathematics and statistics, operations research, systems engineering, and automatic computation has developed rapidly since the operation of its first electronic computer in 1950.

Grant Made to Rutgers Engineering Associates

The Midland-Ross Foundation of Cleveland, Ohio, has made an unrestricted gift of $500 to the Rutgers Engineering Associates, a program established by the College of Engineering at Rutgers, The State University, New Brunswick, N. J., to provide research and educational services for New Jersey industry. Announcement of the grant was made recently by Dr. M. D. Sirkis, acting executive secretary of the organization.

The gift was presented to Rutgers on behalf of the Midland-Ross Foundation by R. E. Dougherty, general manager of the New Brunswick plant of J. O. Ross Engineering, and J. P. Fitzgerald, general manager of John Waldron Corporation. Both are divisions of Midland-Ross Corporation and are located in Highland Park, N. J.

The Rutgers Engineering Associates comprises companies and individuals interested in the advancement of engineering education. Their program includes symposia and conferences designed to meet expressed industrial needs, distribution of bulletins and research reports upon subjects of member interest, purchase of special equipment for instruction and research, support of graduate students, and employment of faculty members on research of interest to the Associates.

Electrical Engineering Education

Engineering Education at Valparaiso University

The College of Engineering at Valparaiso University (VU) was recently accorded national recognition by the Engineers' Council for Professional Development (ECPD) and became one of four schools in Indiana to receive this honor. Others are Notre Dame, Purdue, and Rose Polytechnical Institute.

Engineering education at VU is a tale of 85 years varying from programs of a few electives to major work in eight different areas.

Course offerings in "higher mathematics and surveying–enginering" marked the beginning in 1873.

High point in engineering education came in the roaring twenties. Today's program of mechanical, civil, and electrical engineering was offered plus chemical, aeronautical, commercial, and military engineering and a program of teacher training in industrial arts.

Engineering had advanced to departmental rank by 1883 and in 1893 boasted

CONSOLE of the Univac *1105*, similar to that which will be installed in the spring on the campus of Illinois Institute of Technology, Chicago.

Electrical Engineering Education

a regular 2-year curriculum in civil work.

In 1917, the department became the School of Engineering with 3-year courses in civil, electrical, and mechanical fields. Three years later, the 4-year curriculum was installed.

The depression and World War II undermined the school's stability until, in 1940, the 4-year plan was dropped and engineering reverted to departmental status.

At that time, the VU Board of Trustees negotiated with Purdue University for two co-operative plans. One required 2 years at VU and 3 at Purdue resulting in both A.B. and B.S. degrees. The other, a 4-year program, divided the years equally between the two institutions.

The arrangement continued for 9 years and was terminated early in 1948 by a student-initiated campaign for reinstatement of a 4-year program.

The students proposed to build an engineering laboratory, lack of which was a major drawback to a 4-year program. Funds were not available at the time for current building costs, but the students offered to supply the manpower if university officials would provide the equipment. This plan, which slashed costs considerably, was accepted by the Board of Trustees; and students took over every phase of the idea from fund-raising to construction.

Blueprints were drawn from sketches by Milan Morgan, a faculty member. A team of four students solicited funds from businessmen throughout the Midwest and other aid and encouragement abetted the project.

Some 50 students did the actual construction, the majority at 50¢ an hour. A few "specialists" received $1 per hour.

The students continued working part-time in the fall and winter; and on May 15, 1949, the student-built laboratory was dedicated, making a 4-year program possible again.

Students working on a smaller scale in 1950 constructed Heine Hall, a heating–ventilation lab and engineering reading room. Graland Hall, the engineering drawing building, was added in 1956. This modern drafting and design laboratory is the latest addition to engineering's physical plant. Engineering Annex, the machine tool laboratory, is located on West campus.

The 1949 staff of seven has grown into a well-organized faculty of 19 professors and instructors.

A development in the immediate future will be an attempt by the VU administration and the College of Engineering to develop a co-operative liberal arts engineering program with other Lutheran institutions of higher learning.

National recognition by ECPD opens the door for national societies of electrical, mechanical, and civil engineering on campus. Plans are under way for the formation of an engineering honor society with such affiliation.

The VU College of Engineering, after 85 years of growth, recession, and standing still, has come of age.

Westinghouse Announces New Electric Motor Kit

A new electric motor kit, designed especially for vocational training in public schools, trade schools, industrial schools, and other groups, has been developed by Westinghouse Electric Corporation in co-operation with P. C. Wright of Frederick, Md. Mr. Wright has been appointed the Westinghouse agent for this apparatus.

The Motor Craft Kit consists of an instruction manual and all parts needed for winding and assembling a standard ¼-hp, 115-volt, single-phase, 60-cycle, 1,725-rpm motor. The motor is suitable for use on home power tools, attic fans, blowers, and similar applications.

The illustrated instruction manual included with the motor kit presents in elementary language a step-by-step procedure for winding and assembling the motor. Only common hand tools are required.

To schools, students, and training organizations, the Westinghouse motor kit is priced at $17.50 plus shipping charges from Lima, Ohio.

For schools desiring to re-use the same parts, a rewind kit is available for $6.50, plus shipping charges from Frederick, Md. The rewind kit contains the instruction manual, new coils, leads, cells, and wedges.

The instruction manual itself can be obtained for only $1.50.

Address all inquiries and orders for the motor kit, rewind kit, or manual to P. C. Wright, P. O. Box 562, Frederick, Md.

Summer Institutes at Iowa State College

Iowa State College will hold three special institutes for high school and college teachers in the areas of science, mathematics, and engineering in the summer of 1959.

This was announced recently by the National Science Foundation (NSF), which said approximately 18,000 high school and college teachers will benefit directly from teacher-training programs sponsored by the NSF in 255 educational institutions in all 49 states, Hawaii, Puerto Rico, and the District of Columbia.

Iowa State is almost unique among these institutions in that it has submitted a proposal for an insitute for college and junior college teachers of engineering drawing, engineering problems, and statics of engineering. This proposal has been approved, and 50 selected teachers will be invited to study in this area on the Iowa State campus next summer.

Practically all other institutes by other colleges and universities will be in the area of science or mathematics. Iowa State, which began an institute for high school science and mathematics teachers 3 years ago, will continue that program in 1959 with a group of 80 in the areas of biology, chemistry, mathematics, and physics. This year, the college will add a program for 30 teachers of college and junior college mathematics.

The College will receive approximately $160,800 from NSF to support its three programs. Tuition and fees for the teachers selected will be paid from these funds. The teachers will also receive stipends of $75 per week for the duration of the institute, plus allowances for travel and dependents. All three institutes will run from June 8 to July 17. (Applications may be made to J. A. Greenlee, 12 Beardshear Hall, Iowa State College, Ames, Iowa.)

NSF began its program of summer institutes in 1953, but its first large expansion was in 1957, when Iowa State College joined the group. More colleges and universities have been added this year.

The ultimate objective is to strengthen the teaching programs in science, mathematics, and engineering throughout the nation.

Pratt Student Receives Scholarship

In recognition of high scholastic attainment and demonstration of outstanding potential in the field of electronics, J. E. Daum received a $250 scholarship award recently at a luncheon held at Pratt Institute, Brooklyn, N. Y.

Sheldon Williams, managing director of the Blonder-Tongue Foundation, presented the award to Mr. Daum in the presence of Dr. W. E. Wilson, dean of the School of Engineering and Professor Mahrous, chairman of electrical engineering department.

Mr. Daum, a resident of New York City, and a senior in electronic engineering, will be graduated in June 1959.

Supported by Blonder-Tongue Laboratories, Inc., Newark, N. J., the Foundation presents this annual award to the student who shows the greatest achievement in electronics.

M-H Reactor Simulators Go To Two More Universities

Delivery of reactor simulators to two more United States universities for training of nuclear engineering students was announced by Brown Instruments Division of Minneapolis-Honeywell Regulator Company (M-H).

Latest schools to install the simulators, which electronically duplicate the operational characteristics of costly reactors using uranium fuels, are Syracuse University and University of Minnesota.

Honeywell simulators already are in operation at West Virginia University, University of Oklahoma, and Wayne State University in Detroit and at the University of Toronto.

Practically every kind of reactor problem can be solved on the simulator since instrumentation is the same as that of multimillion dollar "live" reactors.

INSTITUTE ACTIVITIES

Plans Announced for AIEE Joint District Meeting

"INDUSTRY IS HUMMING IN DIXIE" has been selected as the theme for the AIEE Joint District Meeting for the Southeast District No. 4 and South Central District No. 13. The meeting will be held in Atlanta, Ga., April 7-10, 1959. Headquarters for the meeting will be the Dinkler Plaza Hotel.

Technical Sessions

Technically speaking, "Industry Is Humming in Dixie." The 19 sessions and 75 papers on the agenda will be of interest to all engineers. There will be three sessions for student papers.

Inspection Trips

Arrangements have been made for tours to the Georgia Power Company new Operations Headquarters and new 230-kv Substation, the Lockheed Aircraft Corp. in one of the largest manufacturing buildings in the country, the new Owens-Illinois Glass Company Plant and the Ford Motor Company Assembly Plant, the new Automatic Switching and Classification Yard of the Southern Railway Company, the new Rolling Mill and the Electric Steel-Making Facilities of the Atlantic Steel Company, and the recently completed Toll Building of the Southern Bell Telephone & Telegraph Company. In addition, a limited number of people will have the opportunity to play "The Management Game" at the Georgia Tech Computer Center.

General Session

The committee has been fortunate in obtaining a number of Georgia's most prominent citizens as speakers on Wednesday, April 8.

At the general session, His Excellency, Ernest Vandiver, governor of Georgia, will give the address of welcome. Dr. E. D. Harrison, president of the Georgia School of Technology, will have as his subject, the theme of the Joint District Meeting, "Industry Is Humming in Dixie."

At the noon general luncheon, His Honor, W. B. Hartsfield, mayor of Atlanta, will present keys to the City to H. W. Oetinger and C. P. Knost, vice-presidents of Districts No. 4 and No. 13 of AIEE. Dr. Pierce Harris, pastor of the First Methodist Church of Atlanta will address the meeting on a subject of his own choice.

Entertainment

A very attractive full evening's entertainment has been arranged in the form of a dinner-dance on Thursday evening, April 9. Bill Clark's orchestra will supply the music. For after-dinner relaxation, an excellent floor show has been arranged. Tickets to this occasion will be $6 per person.

Hotel Reservations

A housing bureau has been set up to handle advance hotel reservations. All reservations should be made through the Housing Bureau, AIEE, Room 720, Rhodes-Haverty Building, Atlanta, Ga. Confirmation will be mailed to members directly by the hotel accepting the reservation. If rooms at rates requested are not available, a room at the next higher rate available will be assigned. In case assistance is needed, the Chairman, Hotel Committee, should be contacted. Address requests to J. A. Busha, Chairman, Hotel Committee, Southern Bell Telephone & Telegraph Company, 729 Hurt Building, Atlanta, Ga.

Rates for the rooms at the hotels in the vicinity of the headquarters are indicated in the table shown below.

Committee

Members of the Joint District Meeting Committee are: R. G. Elliott, general chairman; J. W. Davis, vice-chairman; W. S. Brown, secretary-treasurer; Mrs. J. W. Davis, women's activity; T. J. Allen, transportation; J. A. Busha, hotel; C. L. Emerson, finance; J. D. Howard, technical program; J. C. Howell, Fersommling; D. C. Kyker, Jr., registration; L. H. Curtis, Jr., publicity; E. G. Riley, inspection; Prof. E. R. Weston, student activities; J. F. Willett, dinner dance; W. J. McKune, vice-chairman, Georgia Section AIEE.

Hotel	Single	For Two Persons: Double Bed	For Two Persons: Twin Beds	Suites
Dinkler Plaza (Hdqrs.)	$7.00-$12.50	$10.00-$12.50	$14.00-$16.50	$12.50-$41.00
Piedmont (across street from Hdqrs.)	6.00- 9.00	9.50- 11.00	10.00- 15.00	25.00- 30.00
Atlantan (1 block from Hdqrs.)	5.00- 7.50	7.00- 9.00	9.00- 11.00	20.00
Georgia (1 block from Hdqrs.)	5.00- 8.00	7.00- 9.00	8.50- 12.00	18.00- 20.00
Peachtree on Peachtree (2 blocks from Hqdrs.)	6.00- 7.00	8.50- 10.50	9.00- 11.50	11.00- 16.00
Henry Grady (2½ blocks from Hdqrs.)	7.00- 14.00	10.00- 16.00	11.00- 16.00	20.00- 35.00
Students, 2 or 3 to a room	2.50 per person			

Courtesy Atlanta Convention Bureau

AERIAL VIEW OF DOWNTOWN ATLANTA, GA., looking in a northwestern direction. Shown in the left foreground are the Georgia State Capitol and the State Office Building, the City Hall, and the Fulton County Court House and Administrative Building. Atlanta will be host to the AIEE Joint District Meeting to be held by the Southeast District and the South Central District, April 7-10, 1959.

Progress Report for AIEE Member-Gifts Campaign

AS OF DECEMBER 1, according to W. E. Scholz, secretary, AIEE Member-Gifts Campaign Committee, the Institute had passed the half-way mark in its fund drive for contributions to the United Engineering Center—reaching 50.5% of its quota of $900,000.

Campaign Extended

When the Member-Gifts Campaign started, the United Engineering Trustees and the Member-Gifts Committees of the various societies set a theoretical completion date as of the end of November 1958.

At a meeting of these various Member-Gifts Committees, it was unanimously agreed that this target date was unrealistic because the campaign only started to take life in October 1958 and the high spots were reached only a short time after that date.

Accordingly, the various Member-Gifts Committees unanimously agreed to press on, to continue all-out efforts to go over their quotas at the earliest possible date.

Campaign Highlights

The following AIEE Sections are now on the honor roll of the "100% Quota Club:"

Section	% of Quota
Schenectady	122
Richland	121
Spokane	102
Pittsburgh	106
Dayton	165
Pittsfield	103

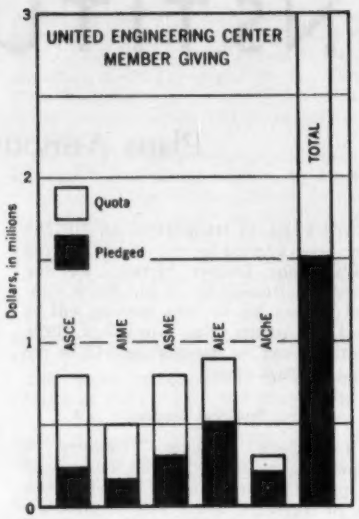
The Sharon & Virginia Mountain Sections have also reached their quotas, and Erie Section has 94% of quota.

Richland Section was the first Section to contact 100% of its members and to turn in its final report.

Sections who have sent in contributions to the Campaign out of their Section funds are as follows:

Section	Amount
New York	$15,000
San Francisco	1,000
Maryland	1,000
Sacramento	500
Los Angeles	1,200

District No. 1 holds the first place, having reached 70% of its quota. In second place is District No. 2 with 52%. District No. 12 is in third place with 51%.



THE BAR GRAPH shows the status of member giving as of December 12, 1958. All contributions to the UET Building Fund are tax deductible.

Professional Pride and Prestige

PLANS TO BUILD a new headquarters in New York City for the principal engineering societies of the United States are well advanced, with more than half of the necessary $10 million already available or pledged. But this is not as good as it sounds, for still teetering on the brink of uncertainty is the truly crucial part of the program. This is the Member Gifts Campaign, just now getting under way, in which engineers are asked to dig down in their own pockets and support this significant undertaking.

Although the results thus far are encouraging, there remains a haunting doubt that engineers have yet sensed the importance of the outcome to themselves personally. For how well and how universally they support this United Engineering Center financing will be used by the world at large to measure how much pride United States engineers have in their profession. The prestige of engineering will go up or down according to the results, which cannot fail to affect the economic status and community standing of every engineer. The campaign for a new headquarters of engineering is thus not just another fund-raising drive, but a challenge to engineers to stand up and be counted.

As the campaign now stands there is another facet to the challenge that engineers cannot afford to overlook. Having asked and obtained the co-operation of industrial leaders to raise $5 million of the total, engineers are in the position of seeing 70% of this total subscribed, while less than 15% of their commitment has been pledged. Moreover, this commitment is only $3 million compared to industry's $5 million, since $2 million will be available from the sale of the present headquarters, which was a gift 50 years ago from Andrew Carnegie.

Every engineer should take a keen interest in the success of the UEC campaign, but it is of course the 180,000 members of the five major societies—Civils, Miners, Mechanicals, Electricals, and Chemicals—who must bear the main responsibility because it is they who will own the new building and profit most directly from it. Actually, each individual subscription would be extremely modest if every member could be counted on to do his share—less than $20 per head, and with payment spread over 3 years if desired. But, since universal support is never possible, engineers must be counted on to give according to their abilities, which vary according to the rewards that engineering has afforded them. Instead of $20 some should give $2,500, and others should give various amounts up and down the scale. The principal requirement is for every engineer to recognize his responsibility and act upon it.

The pride and prestige that immediate financial support will insure will be enhanced for many years to come by the building itself. It will occupy a block-long site facing New York's United Nations Plaza—a world center attracting thousands of visitors every day. To them, the building's 20-story tower will symbolize engineering's importance. And inasmuch as the building will house not only the 5 societies that own it, but 16 other engineering societies and organizations, it will also symbolize and promote the cause of unity in the profession—another increase to prestige.

These pride and prestige factors are in addition to the very tangible contribution that the building will make in improving operating efficiency of the headquarters staffs of the engineering societies. When the present building was built, they handled the affairs of 16,000 members. Now there are more than 10 times that number. Moreover, when the present building was built, engineering served an economy measured by a gross national product of about $35 billion; this year's figure will be $435 billion. A headquarters building commensurate with this growth obviously is necessary for the service that engineering is expected to render.

If engineering is more than a casual occupation—and statements to the contrary are seldom voiced—the new United Engineering Center, financed in substantial part by engineers themselves, will lend these claims real substance. Conversely, failure to support it can readily be taken by the world at large as an indication that engineers do not place as much stock in themselves and their profession as their frequent assertions would seem to imply.

That such an opinion, were to become common, would be damaging to the rising prestige of engineering can hardly be questioned. It is equally certain that such damaged prestige would inevitably have a bad effect on the economic status and community standing of engineers. It is up to the engineers of the country, each acting individually, to see that this does not happen.

This editorial on the United Engineering Center is reprinted from *Engineering News-Record*, October 1958. Copyright 1958, McGraw-Hill Publishing Co., Inc.

AIEE Future Meetings

Winter General Meeting*
Statler Hotel
New York, N. Y.
February 1-6, 1959

AIEE-IRE-U of P Transistor and Solid-State Circuits Conference*
University of Pennsylvania
Philadelphia, Pa.
February 12-13, 1959

AIEE-IRE-ACM Western Joint Computer Conference*
Fairmont Hotel
San Francisco, Calif.
March 3-5, 1959

American Power Conference*
Sherman Hotel
Chicago, Ill.
March 31-April 2, 1959

Textile Industry Conference*
Heart of Atlanta Motel
Atlanta, Ga.
April 2-3, 1959

EJC Nuclear Congress*
Municipal Auditorium
Cleveland, Ohio
April 5-10, 1959

AIEE-AWS Electric Welding Conference*
Hotel Sherman
Chicago, Ill.
April 6-10, 1959

AIEE-ASME Railroad Conference
Chicago, Ill.
April 7-9, 1959
(Final date for †TP—closed ‡CP Syn.—closed, CPMs—Feb. 2)

Southern District Meeting
Dinkler Plaza Hotel
Atlanta, Ga.
April 8-10, 1959
(Final date for †TP—closed, DPMs—Feb. 2)

Electric Heating Conference
Bellevue-Stratford Hotel
Philadelphia, Pa.
April 14-15, 1959
(Final date for †TP—closed, ‡CP Syn.—closed, CPMs—Feb. 9)

Electrical Problems in the Cement Industry Conference
Americus Hotel
Allentown, Pa.
April 15-16, 1959
(Final date for †TP—closed, ‡CP Syn.—closed, CPMs—Feb. 9)

Recording and Controlling Instruments Conference
Bellevue-Stratford Hotel
Philadelphia, Pa.
April 20-21, 1959
(Final date for †TP—closed, ‡CP Syn.—Feb. 3, CPMs—Feb. 13)

East Central District Meeting
Sheraton-Mayflower Hotel
Akron, Ohio
April 22-24, 1959
(Final date for †TP—closed, DPMs—Feb. 16)

Rubber and Plastics Conference
Sheraton-Mayflower Hotel
Akron, Ohio
April 22-24, 1959
(Final date for †TP—closed, ‡CP Syn.—Feb. 6, CPMs—Feb. 16)

Empire District Meeting
Hotel Syracuse
Syracuse, N. Y.
April 29-May 1, 1959
(Final date for †TP—closed, DPMs—Feb. 23)

AIEE-IRE-EIA-WCEMA Joint Electronic Components Conference
Benjamin Franklin Hotel
Philadelphia, Pa.
May 6-8, 1959
(Final date for †TP—Feb. 5, ‡CP Syn.—Feb. 20, CPMs—March 2)

AIEE-ASME-IRE Automatic Techniques Conference
Pick Congress Hotel
Chicago, Ill.
May 11-13, 1959
(Final date for †TP—Feb. 10, ‡CP Syn.—Feb. 24, CPMs—March 6)

Domestic Appliances Conference
Hotel Manger
Cleveland, Ohio
May 18-19, 1959
(Final date for †TP—Feb. 17, ‡CP Syn.—March 3, CPMs—March 13)

Middle Eastern District Meeting
Lord Baltimore Hotel
Baltimore, Md.
May 19-21, 1959
(Final date for †TP—Feb. 18, DPMs—March 13)

AIEE-ISA-ARS-IAS National Telemetering Conference
Brown Palace and Cosmopolitan Hotel
Denver, Colo.
May 24-27, 1959
(Final date for †TP—Feb. 23, ‡CP Syn.—March 10, CPMs—March 20)

International Conference on Information Processing
UNESCO House
Paris, France
June 15-20, 1959
(Exhibits June 13-22)

Paper and Pulp Conference
University of Maine
Orono, Maine
June 18-19, 1959
(Final date for †TP—March 20, ‡CP Syn.—April 3, CPMs—April 14)

Summer and Pacific General Meeting
Olympic Hotel
Seattle, Wash.
June 21-26, 1959
(Final date for †TP—March 23, ‡CP Syn.—April 7, CPMs—April 17)

Air Transportation Conference
(at Summer General Meeting)
Olympic Hotel
Seattle, Wash.
June 22-26, 1959

Petroleum Industry Conference
Wilton Hotel
Long Beach, Calif.
August 23-26, 1959
(Final date for †TP—May 25, ‡CP Syn.—June 9, CPMs—June 19)

AIEE-NEMA National Electrical Insulation Conference
Chicago, Ill.
September 9-11, 1959
(Final date for †TP—June 11, ‡CP Syn.—June 26, CPMs—July 6)

AIEE-ASME Engineering Management Conference
Statler Hotel
Los Angeles, Calif.
September 16-18, 1959
(Final date for †TP—June 18, ‡CP Syn.—July 3, CPMs—July 13)

AIEE-IRE Magnetic Amplifiers Conference
Shoreham Hotel
Washington, D. C.
September 23-25, 1959
(Final date for †TP—June 22, ‡CP Syn.—July 10, CPMs—July 20)

Fall General Meeting
Morrison Hotel
Chicago, Ill.
October 11-16, 1959
(Final date for †TP—June 12, ‡CP Syn.—July 30, CPMs—Aug. 7)

*Final date for submitting papers—closed

†TP—Transactions Paper
‡CP Syn.—Conference Synopsis
CPMs—Conference Manuscript
DPMs—District Manuscript
(District Paper Synopses should be directed to the District Meeting Committee)

Transactions and conference papers must conform to the requirements in *Authors Guide*. For a copy, write to E. C. Day AIEE, 33 W. 39th St., New York 18, N.Y.

Electric Welding Conference April 6-10, 1959, Chicago, Ill.

The Electric Welding Conference, sponsored jointly by AIEE and the American Welding Society, will be held April 6-10, 1959, at the Hotel Sherman, Chicago, Ill. A tentative technical program of AIEE participation in the Conference follows.

Tuesday, April 7

Morning Session—Arc Welding Power Supplies

Characteristics of Rectifier Type High-Current D-C Supplies for New Welding and Arc Processes. *Robert Stuefen,* A. O. Smith Corporation

Design Precautions for Proper Application of Silicon Rectifiers to Arc and Similar High-Transient Voltage and Current Loads. *Dennis Pierce,* A. O. Smith Corporation

A Report on the Revitalization of the Multiple-Operator Power Source Welding System. *William Faust,* A. O. Smith Corporation

Afternoon Session—Welding Arc Fundamentals

An Analysis of Transfer in Gas-Shielded Welding Arcs. *W. J. Greene,* Air Reduction Company

The Measurement and Significance of Temperature in Welding Arcs. *H. D. Ludwig,* Westinghouse Electric Corporation

A New Magnetic Arc Method for the Electric Welding of Refractory Glasses and Ceramics. *E. M. Guyer,* Corning Glass Works

Wednesday, April 8

Morning Session—Resistance Welding

The Effect of Elevated Temperatures on Flash-Welded Aluminum-Copper Joints. *C. R. Dixon, F. G. Nelson,* Aluminum Company of America

Discussion of Direct-Writing Instrumentation for Certain Applications in the Field of Resistance Welding. *W. K. Whittemore,* Brush Instruments

A Direct-Reading RMS Meter for Measuring Secondary Resistance Welding Current. *Dr. E. F. Nippes, H. S. Ferguson, Dr. W. F. Savage,* Rensselaer Polytechnic Institute, (Duffers Associates, Inc.)

Thursday, April 9

7:00 p.m. Special Program on Control Systems

Sponsored by the Industrial Group of the Chicago Section, AIEE, and Recommended by the Committee on Electric Welding. (Western Society of Engineers Building)

The Logic Approach to Welding Control Systems. *R. C. Mierendorf, C. R. Whitney,* Square D Company

Report on U.S. Contributions to ICIP

The United States appears to hold a dominant position on the advance program of the First International Conference on Information Processing (ICIP), to be held in Paris, France, June 13-22, 1959, according to official figures released recently. In a report to the Eastern Joint Computer Conference, held in Philadelphia, Pa., December 3-5, 1958, I. L. Auerbach, chairman of the United States Committee for the ICIP, told American sponsors—AIEE, Institute of Radio Engineers (IRE), Association for Computing Machinery (ACM)—that the United States has one third of the 74 global abstracts presently accepted in Paris.

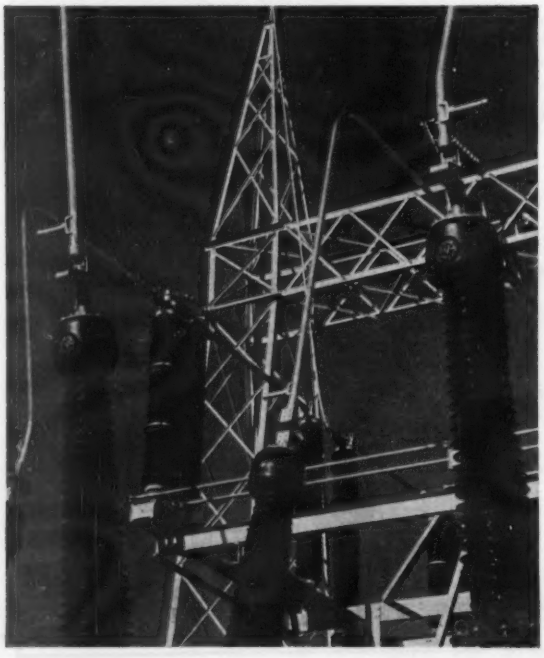
In addition, 5 of 13 planned symposia will be co-ordinated by American computer experts. Many global abstracts from the United States that did not appear on the provisional advance program have been referred to symposia co-ordinators as possible contributions to the topical areas to be covered.

Despite this significant lead shown by the United States, Mr. Auerbach warned that approximately 25% of the total papers listed in the provisional advance program will be eliminated from the final plenary session program to meet the tight schedule of the 5-day technical conference. The final selection of papers will be made in Paris in early February by national consultants to United Nations Educational, Scientific, and Cultural Organization, sponsor of the Conference. Mr. Auerbach, who is president of Auerbach Electronics Corporation, Narberth, Pa., is the United States consultant to Unesco and IRE's representative to USICIP.

For the preliminary selection of global abstracts Mr. Auerbach was joined in Paris by Dr. Alston Householder, chairman of the United States Program Committee of USICIP and also the ACM representative. Dr. Householder, of Oak Ridge National Laboratory, had worked with a group of computer experts from all over the United States to evaluate the 90 abstracts received from this country. They were ordered into several degrees of choices for presentation to the International Program Committee.

In his progress report, Mr. Auerbach announced that the world-wide exhibition of information processing equipment, which will be held at the Grand Palais in Paris, June 13-23, 1959, in conjunction with the ICIP, will be called AUTOMATH 1959 (Automatic Mathematics 1959). The Grand Palais is only a few minutes from Unesco House, site of the Conference.

AUTO-MATH 1959 will give a general view of research and progress in information processing. Exhibits will be limited to the latest findings and techniques in this field, displaying appropriate systems and related components. The Grand Palais will be accepted as a bonded warehouse, thus enabling exhibits to be shipped free of customs duty in care of Unesco. Formal technical papers on data processing equipment in the exhibit, or announcing new equipment developments, will be heard on June 22-23. Dr. Eugene Grabbe, of Thompson Ramo Wooldridge, is chairman of the United States Exhibits Committee.



PORTER SUBSTATION of the Niagara Mohawk Power Corp. located at Deerfield, N.Y. This substation is the main tie connection for the 220-kv St. Lawrence power with Niagara Mohawk's east-west 115-kv trunk transmission system. The photo shows part of the 220-kv bus structure disconnecting switch and bushings for the circuit breakers. The theme for the Empire District Meeting, to be held in Syracuse, is "New Horizons in Power and Industry."

Empire District Meeting To Be Held in Syracuse, N.Y.

The Spring Meeting of the AIEE Empire District No. 1 will be held at Syracuse, N. Y., on April 29-May 1, 1959. The following committee chairmen have been named: General Chairman—Paul Kartluke, Technical Program—A. F. Paskevich, Finance—B. T. Cole, Publicity—E. A. Gruppe, Hotel Arrangements—D. J. Williams, Registration—C. E. H. Von Sothen, Banquet—C. N. Palmer, Smoker—J. W. Becker, Student Activities—E. W. Kosso.

The theme for the meeting will be "New Horizons in Power and Industry." Much work has been done in the planning of a program of wide interest including, but not limited to, atomic power, computers, automation and data processing, and extra high-voltage transmission.

Board of Directors Announces Results of NSPE Questionnaire

THE Board of Directors of the Institute in June 1956 originated a proposal for the organization of the engineering profession, which has since come to be known as the Functional Plan (*Electrical Engineering*, February 1958, p. 119). The Board at the same meeting took another action in which it suggested to the National Society of Professional Engineers (NSPE) that that societ; open its membership "for a period of years, to unregistered engineers holding suitable grades in technical societies subscribing to ECPD (Engineers' Council for Professional Development) uniform membership grade standards." The "suitable grades" in AIEE would be Fellow and Member. This suggestion was made in the belief that its adoption would strengthen NSPE in the role proposed for it under the Functional Plan.

NSPE has the established policy of encouraging each of its members to join the appropriate technical society, such as AIEE, American Society of Mechanical Engineers (ASME), American Society of Civil Engineers (ASCE), etc. AIEE has for many years recommended to its members that they register as professional engineers. The AIEE Board of Directors has told NSPE that if the previously mentioned suggestion is adopted by that society, the Institute will urge all its members to affiliate with NSPE, whether registered or not.

This suggestion is actively being considered by NSPE for implementation at the national level, but has not yet been adopted. They have, however, recommended that their constituent state societies "take such steps as may be necessary to admit properly qualified persons to membership." To assist in further discussions with NSPE, the AIEE Board of Directors on September 22, 1958, sent the following questionnaire with an accompanying explanation to 13,905 Fellows and Members of the Institute in the United States:

The response of 9,934 replies (71%) was gratifying. The responses are tabulated below. The replies which were consistent with the questionnaire in all respects numbered 7,398 (53%). These showed the following:

Registered

4,649 (63%)

Members NSPE	Nonmembers NSPE
2,130 (46%)	2,519 (54%)

Nonregistered

2,749 (37%)

Would Join NSPE	Would Not Join NSPE
1,956 (71%)	793 (29%)

1. Your present membership grade — Member ☐ Fellow ☐
2. Your age bracket — 20–29 ☐ 30–39 ☐ 40–49 ☐ 50–59 ☐ 60 & over ☐
3. Are you a Registered Professional Engineer? Yes ☐ No ☐
4. Do you belong to NSPE? Yes ☐ No ☐

If you answered "No" to questions 3 & 4, please answer question 5.

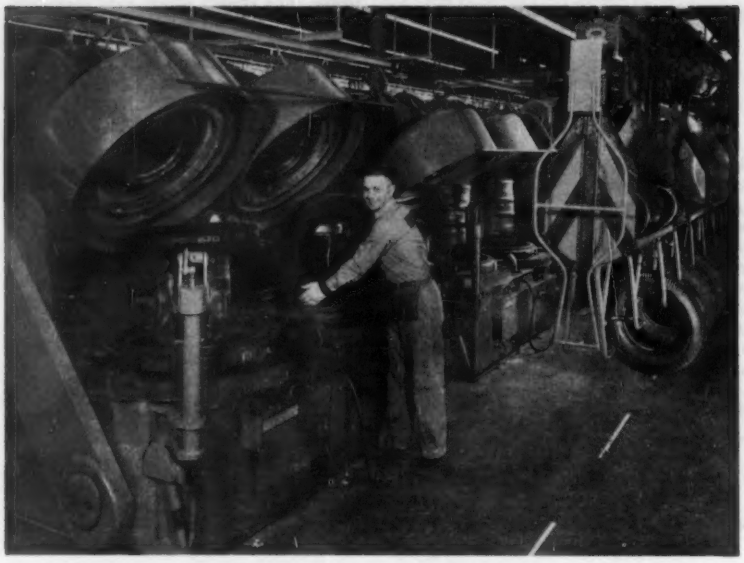
5. Would you join NSPE if AIEE Members & Fellows were eligible for membership even though not Registered Professional Engineers? Yes ☐ No ☐

Please detach and mail (No stamp) Sign only if you wish.

NSPE QUESTIONNAIRE. Mailed: Members—12,452; Fellows—1,453; Total—13,905. Returned: Members—8,888; Fellows—1,028; Misc.—18; Total—9,934. Answers: Y-yes, N-no, B-blank.

Answers to Questions	Age 20 - 29		Age 30 - 39		Age 40 - 49		Age 50 - 59		Age 60 & Over		Total
3 - 4 - 5	M	F	M	F	M	F	M	F	M	F	
Y - Y - Y			5		8	1	17	5	14	8	58
Y - Y - N			6		8		18	6	12	2	52
Y - Y - B	1		300		598	13	675	142	284	117	2130
Y - N - Y			74		141	5	203	18	94	32	567
Y - N - N			227		369	11	503	49	311	159	1629
Y - N - B			428	1	735	15	762	122	309	147	2519
N - Y - Y			3								3
N - Y - N											
N - Y - B											
N - N - Y	2		438	1	599	5	590	22	269	30	1956
N - N - N			120		164	2	179	25	235	68	793
N - N - B			36		43	3	47	2	26	9	166
Total	3		1637	2	2665	55	2994	391	1554	572	9873 +61 Y-B-B

1959 East Central District Meeting



AUTOMATIC CURING AND CONVEYING of tires is one of the final steps in tire manufacturing as shown (above) at Firestone Tire & Rubber Co., Akron, Ohio. Akron, the capitol of the rubber industry, will be host to the 1959 East Central District Meeting of the AIEE on April 22-24. This 75th Anniversary meeting will be held concurrently with the annual Rubber and Plastics Technical Conference at the Sheraton Hotel. In addition to the technical papers, inspection trips through the rubber plants and other industries are planned.

AIEE Member Is Guest on "Science Calling"

Jules Schick Photography

T. H. MACCAULEY *(right)*, chairman of the Radio Committee of the AIEE Philadelphia Section, was a recent guest on "Science Calling," a radio program on station WRCV (NBC) in Philadelphia, Pa. Mr. MacCauley's discussion included thoughts on his recent trip to the West Coast, Hawaii, and the Orient, as well as remarks on the AIEE's 75th Anniversary and one of the Institute's first subjects in 1884, the "Edison Effect." Shown with Mr. MacCauley are: Paul Taylor *(left)*, WRCV editor and a leading newspaper newsman; and Fred Harper *(center)*, producer-director, who heads up the program. "Science Calling," on 13 radio and television stations owned by NBC in 8 major cities, has co-operated in a public service project focusing attention on the need for more trained scientists.

Nominating Committee Will Meet February 2, 1959

The AIEE Nominating Committee will meet in the Buffalo Room, Hotel Statler, New York, N. Y., 9:00 a.m. February 2, 1959, during the Winter General Meeting of the Institute, to nominate candidates for AIEE offices to be voted on by the membership in the Spring of 1959. Representatives receive travel allowance. Alternates are required to attend only if called upon to serve in place of their representative. (See Constitution C30, 31, 32, 33; Bylaws B27, 28; and *Electrical Engineering*, November 1958, p. 1055-56.) Members of the committee are as follows:

Representing the 13 Geographical Districts:

1. J. W. Becker, Allis-Chalmers Manufacturing Co., 472 Salina St., Syracuse, N. Y.
2. L. L. Nonemaker, Pennsylvania Power & Light Co., 901 Hamilton St., Allentown, Pa.
3. W. T. Rea, Bell Telephone Labs., Inc., Mountain Ave., Murray Hill, N. J.
4. H. A. Clarke, Appalachian Electric Power Co., Box 2091, Roanoke, Va.
5. F. W. Bush, Allis-Chalmers Manufacturing Co., Box 512, Milwaukee, Wis.
6. J. E. Lagerstrom, 2331 Donald St., Ames, Iowa.
7. Ralph Randall, 714 N. W. 33rd St., Oklahoma City 18, Okla.
8. W. E. MacMorran, Mountain States Tel. & Tel. Co., 16 W. McDowell Road, Phoenix, Ariz.
9. H. R. Loew, General Electric Co., Seattle, Wash.
10. G. F. Tracy, Electrical Bldg., University of Toronto, Toronto 5, Ont., Canada.
11. Frederick von Voigtlander, Cummins & Barnard, Inc., 109 E. Washington St., Ann Arbor, Mich.
12. E. E. Linden, Narragansett Electric Co., Box 1686, Providence, R. I.
13. A. J. Lehman, Freeport Sulphur Co., Box 1520, New Orleans, La.

Alternates:

1. C. J. Fitch, 209 West Edward St., Endicott, N. Y.
2. E. A. Winslow, 432 Wengler Ave., Sharon, Pa.
3. W. G. Vieth, Western Union Telegraph Co., 60 Hudson St., New York 13, N. Y.
4. R. H. Stevens, Florida Power & Light Co., Miami, Fla.
5. W. M. Ballenger, General Electric Co., 840 S. Canal St., Chicago 80, Ill.
6. F. E. Baird, 816 Telephone Building, Des Moines, Iowa.
7. First Alternate: Clarence Anthony, Oklahoma Gas & Elec. Co., 3rd & Harvey Sts., Oklahoma City, Okla.
   Second Alternate: J. S. Wyble, Westinghouse Elec. Corp., 865 First National Bldg., Oklahoma City, Okla.
8. C. A. Poppino, General Electric Co., Phoenix, Ariz.
9. H. R. Brown, 9221 47th Ave., S. W., Seattle 16, Wash.
10. B. G. Ballard, National Research Council, Sussex Drive, Ottawa, Ont., Canada.
11. J. R. North, Commonwealth Associates, Inc., 209 E. Washington Ave., Jackson, Mich.
12. F. S. Bacon, Jr., P. O. Box 58, Winchester, Mass.
13. M. L. Hurstell, New Orleans Public Service, Inc., 317 Baronne St., New Orleans, La.

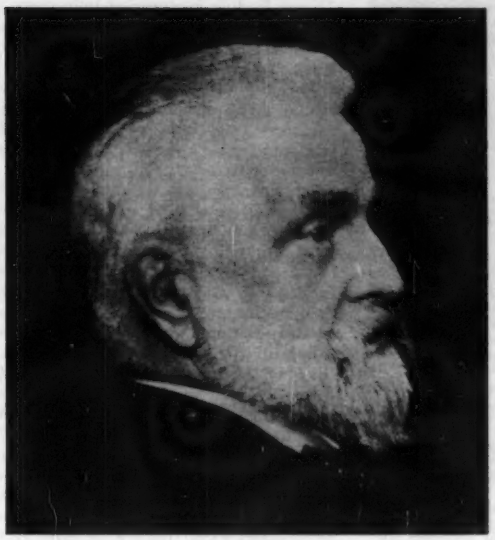
Representing the six Technical Divisions:

Communication—J. Meszar, Bell Telephone Labs, Inc., 463 West St., New York 14, N. Y.
General Applications—H. F. Hoebel, American Electric Power Service Corp., P. O. Box 487, Canton 1, Ohio.
Industry—R. H. Whaley, Eli Lilly & Co., 740 S. Alabama St., Indianapolis 6, Ind.
Instrumentation—Ferdinand Hamburger, Jr., Johns Hopkins University, Homewood, Baltimore 18, Md.

(Continued on p. 180)

Two New AIEE Medals Announced

Request Made for Nominees

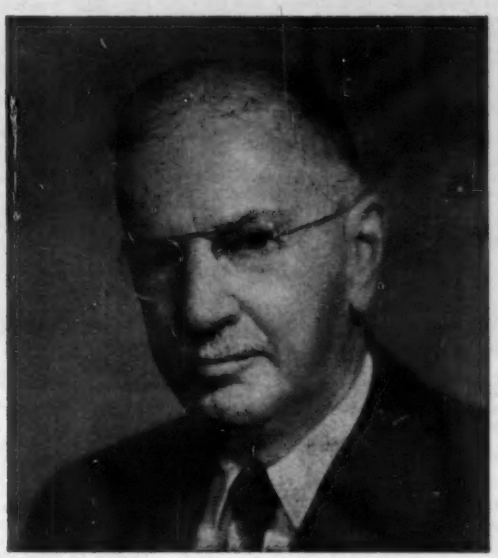


William M. Habirshaw

The WILLIAM MARTIN HABIRSHAW AWARD established by the Phelps Dodge Foundation will be awarded annually to an individual or group of individuals who have made an outstanding contribution to the field of Electrical Transmission and Distribution.

The selection of the recipient of this award is made by the Recognition Awards Committee of the AIEE. The award consists of a cash stipend of $500, a bronze medal, and a suitably engraved certificate. In the event that the recipient is a group of individuals, the stipend shall be equally divided among the members of the group, and a medal and certificate provided for each.

The first presentation is to be made at the Fall General Meeting to be held in Chicago, Ill., October 11-16, 1959. The Committee invites all members of the Institute to submit nominees. Such nominations are to be made on a form which may be procured from the Secretary of the Recognition Awards Committee, Mrs. A. L. Landres, AIEE Headquarters, 33 W. 39th Street, New York 18, N.Y. The form should be accompanied by supporting letters from others who are familiar with the accomplishments and qualifications of the nominee. The forms and letters are due at Headquarters not later than May 1, 1959.



Morris E. Leeds

The MORRIS E. LEEDS AWARD established by the Leeds & Northrup Foundation will be awarded annually to an individual or group of individuals who have benefited the arts and sciences by making an outstanding contribution to the field of Electrical Measurement, with special consideration given to the value of contributions made before the candidate has reached his 36th birthday.

The selection of the recipient for this award is made by the Recognition Awards Committee of the AIEE. The award consists of a cash stipend of $500 and a suitably engraved certificate. In the event that the recipient is a group of individuals, the stipend shall be equally divided among the members of the group, and and a certificate provided for each.

The presentation of the first award is to be made at the Fall General Meeting to be held in Chicago, Ill., October 11-16, 1959. The Committee invites all members of the Institute to submit nominees. Such nominations are to be made on a form which may be procured from the Secretary of the Recognition Awards Committee, Mrs. A. L. Landres, AIEE Headquarters, 33 W. 39th Street, New York 18, N.Y. The form should be accompanied by supporting letters from others who are familiar with the accomplishments and qualifications of the nominee. The forms and letters are due at Headquarters not later than May 1, 1959.

(Continued from p. 178)

Power—E. I. Pollard, Elliott Company, 271 Church St., New York 13, N. Y.
Science and Electronics—D. E. Truckses, Bell Telephone Labs., Inc., 463 West St., New York 14, N. Y.

Alternates:

Communication—C. E. Dean, Hazeltine Corporation, 5825 Little Neck Parkway, Little Neck 62, N. Y.
General Applications—L. R. Larson, The Martin Co., Denver Div., P. O. Box 179, Denver, 1, Colo.
Industry—J. F. Deffenbaugh, Federal Machine & Welder Co., Overland Ave., Warren, Ohio.
Instrumentation—P. K. McElroy, General Radio Company, 22 Baker Ave., West Concord, Mass.
Power—F. L. Lawton, Aluminum Laboratories Ltd., 1800 Sun Life Bldg., Montreal, Que., Canada.
Science and Electronics—E. L. Harder, Westinghouse Electric Corp., 1204 Milton St., Pittsburgh 18, Pa.

Representing the Board of Directors:

W. J. Barrett, New Jersey Bell Tel. Co., 540 Broad St., Newark 1, N. J.
M. S. Coover, Iowa State College, Dept. of Elec. Engg., Ames, Iowa.
L. F. Hickernell, Anaconda Wire & Cable Co., Hastings on Hudson 6, N. Y.
A. A. Johnson, Westinghouse Electric Corp., East Pittsburgh, Pa.
J. C. Strasbourger, Muncie Engg. Inc., Mitchell Maintenance Co., Lift-A-Loft Co., 400 E. Jackson St., Box 1225, Muncie, Ind.
P. G. Wallace, Texas Power & Light Co., Fidelity Union Life Bldg., Box 6331, Dallas, Tex.

Alternates:

W. R. Brownlee, Southern Services Inc., Birmingham, Ala.
W. R. Clark, Leeds & Northrup Co., 4901 Stenton Ave., Philadelphia 44, Pa.
J. D. Tebo, Bell Telephone Labs., Inc., Whippany, N. J.

The following provisions of the Constitution and Bylaws relate to the organization and procedures of the Nominating Committee.

Constitution

C30. There shall be constituted each year a Nominating Committee consisting of one representative of each geographical District, elected by its executive committee, one representative of each technical division elected by the division committee, and other members chosen by and from the Board of Directors not exceeding in number the number of technical divisions; all to be selected when and as provided in the Bylaws. The Secretary of the Institute shall be the secretary of the Nominating Committee, without voting power.

C31. The Executive Committee of each geographical District shall act as a nominating committee of the candidate for election as Vice-President of that District, or for filling a vacancy in such office for an unexpired term, whenever a vacancy occurs.

C32. The Nominating Committee shall receive such suggestions and proposals as any member or group of members may desire to offer, such suggestions being sent to the secretary of the committee.

The Nominating Committee each year shall name one or more candidates for President, Treasurer, and the proper number of Directors, and shall include in its ticket such candidates for Vice-Presidents as have been named by the nominating committees of the respective geographical Districts, if received by the Nominating Committee when and as provided in the Bylaws; otherwise the Nominating Committee shall nominate one or more candidates for Vice-President (s) from the District (s) concerned.

C33. Independent nominations may be made by a petition of twenty-five (25) or more corporate members sent to the Secretary when and as provided in the Bylaws; such petitions for the nomination of Vice-Presidents shall be signed only by members within the District concerned.

Bylaws

B27. The Secretary of the Nominating Committee shall give the members . . . not less than ten days notice of the first meeting of the committee, which shall be held not later than February fifteenth. At this meeting, the committee shall elect a chairman and shall proceed to make up a ticket of nominees for the offices to be filled at the next election. To insure that full consideration be given to all suggestions from the general membership, they must be in the hands of the secretary of the committee by December fifteenth. The nominations as made by the Nominating Committee shall be published in the April issue of *Electrical Engineering*, or otherwise mailed to the Institute membership not later than the last week in March.

B28. Petitions proposing the names of candidates as independent nominations for the various offices to be filled at the ensuing election, in accordance with C33 (Constitution) must be received by the Secretary of the Nominating Committee not later than March fifteenth of each year, to be placed before that committee for the inclusion in the ballot of such candidates as are eligible.

B28.1 The candidates shall appear on the ballot, grouped alphabetically under the name of the office for which each is a candidate. The voting in each case shall be restricted to the nominees printed on the ballot. The ballot shall be mailed to the membership by April 15.

Sponsors Announced for 1959 National Engineers' Week

Some leading engineering luminaries in a variety of fields have agreed to act as sponsors for the 1959 National Engineers' Week, February 22-28.

The list of sponsors, which includes several AIEE members, is made up of engineers from industry, education, private practice, Government service, and the military.

The sponsors are: Wernher von Braun, director, Development Operations Division, Army Ballistic Missile Agency; A. B. DuMont (F '43), chairman of the board, Allen B. DuMont Laboratories, Inc.; T. K. Glennan, president-on-leave, Case Institute of Technology, and administrator, National Aeronautics and Space Administration; Maj. Gen. E. C. Itschner, chief of engineers, U. S. Army; J. R. Killian, Jr., special assistant to the President of the United States for science and technology; C. H. Linder (F '57), vice president, General Electric Company; T. E. Murray (F '33), consultant, Joint Committee on Atomic Energy; G. M. Read, chief engineer, E. I. du Pont de Nemours & Co. (Inc.); Rear Adm. H. G. Rickover, chief of naval reactors, U. S. Atomic Energy Commission; R. W. Sorensen (HM '54), California Institute of Technology; Philip Sporn (F '30), president, American Gas and Electric Company; D. B. Steinman, consulting engineer; B. D. Tallamy, Federal Highway Administrator; and C. A. Thomas, president, Monsanto Chemical Company.

Engineers See Slides of Russian Power Plants

J. H. Foote, president of Commonwealth Associates, Jackson, Mich., and past AIEE District vice-president, was guest speaker at the regular meeting of the Arrowhead Section of AIEE on November 14, 1958, at the Duluth Athletic Club.

Mr. Foote presented his slides of Soviet electric power plants and discussed his 1957 trip through Europe studying electric power systems and associated technical matters. During this trip, he spent 15 days in the USSR, visiting Leningrad, the Ukraine, and Moscow where he attended the meetings of the International Electrotechnical Commission as a delegate from the U. S. National Committee on Standardization of Electrical Systems and Equipment.

Mr. Foote also presented a past chairman appreciation certificate to J. E. Abramson, D.M. & I.R. Railway Co., Proctor.

The Arrowhead Section of AIEE has about 200 members and affiliates from northern Minnesota, Wisconsin, and Michigan.

J. E. ABRAMSON (*left*), past chairman, AIEE Arrowhead Section, receives past chairman certificate from J. H. Foote (*right*), past District vice-president. P. L. Bush (*center*), Section chairman, observes the presentation.

Los Angeles Section Hears About Nuclear Power

Nuclear Power was the subject of the November Annual Joint Meeting of the Los Angeles Sections of the AIEE and Institute of Radio Engineers (IRE). The members heard Dean Stafford Warren of the University of California at Los Angeles School of Medicine and Dr. Chauncy Starr, vice-president and general manager of Atomics International, speak about their activities in the nuclear power field.

Dean Warren discussed the medical problems concerning atomic radiation and what effect it has upon the human body. He stressed the fact that medical science has just scratched the surface in ascertaining the effects of atomic radiation.

Dr. Starr, the technical speaker, told the members about the state of the art at the present and what could be expected in the future. In his talk, he covered the technical, political, and economic aspects of nuclear energy, from a local, national, and international level.

Rothschild Photo

LOS ANGELES SECTION OFFICERS of the AIEE and IRE discuss their respective section organization's publication, at the November Annual Joint Meeting. Standing are *(left to right)*: Robert Milmoe, secretary-treasurer of AIEE holding the IRE publication; Fred Foulon, vice-chairman, AIEE; E. D. Barcus, chairman, AIEE; L. C. Van Atta, chairman, IRE; Burgess Dempster, vice-chairman, IRE, holding the AIEE publication.

Call for Papers— Automatic Control Conference

Technical papers are now being solicited for the 1959 National Automatic Control Conference, sponsored by the Institute of Radio Engineers (IRE) Professional Group on Automatic Control, with official participation by the AIEE, the Instrument Society of America, and the IRE Professional Group on Industrial Electronics. The Conference will be held November 4-6, 1959, at the Sheraton Hotel, Dallas, Tex.

Before the deadline of June 1, 1959, four copies of summaries should be submitted to the Technical Program Chairman, G. S. Axelby, Westinghouse Electric Corporation, Box 746, Baltimore 3, Md.

In order to facilitate selection of papers, the 1,000- to 1,500-word summary must:

(1) State clearly what has been accomplished.

(2) Indicate whether (a) the material is primarily theoretical or experimental, (b) practical applications are included and (c) the paper is believed to be an original contribution or an extension of an earlier paper.

(3) Include a pertinent bibliography.

Accepted papers will be published.

Montgomery Subsection Holds Meeting with AFCEA

On October 28, the Montgomery Area Chapter of the Armed Forces Communications and Electronics Association (AFCEA) and the Montgomery Subsection of AIEE held a joint meeting at Maxwell Air Force Base. The joint meeting began at 5:30 p.m. with a social hour for members, their wives, and guests at the Maxwell Air Force Base Officers Club. This included a buffet dinner. Lt. Col. Herbert Herman, U.S.A.F., Communications, Electronics Doctrinal Project Office, Air Command and Staff College, Maxwell Air Force Base, president of the Montgomery Area Chapter of AFCEA, and C. S. Weiss, district engineer, Southern Bell Telephone Company, chairman of the Montgomery Subsection of AIEE, greeted the many distinguished guests that were present. Mayor W. A. Gayle of the City of Montgomery; L. R. Grimes of the Montgomery County Board of Revenue; and Maj. Gen. J. F. Berry, adjutant general for the State of Alabama, were among the many guests present representing the city, county, and state governments. Frank Newton, vice-president and general manager of Southern Bell Telephone Company, Birmingham; E. A. Wilson, manager, power sales department, Alabama

Paul Robertson Photographer

CONVERSING at a recent meeting held jointly by the Montgomery Subsection of AIEE and the Montgomery Area Chapter of the AFCEA are *(left to right)*: C. N. Hoyler, Radio Corporation of America Laboratories; Lt. Col. Herbert Herman, Air Command and Staff College, president of the Montgomery Area Chapter of AFCEA; Frank Newton, vice-president and general manager of Southern Bell Telephone Company, Birmingham, Ala.; and C. S. Weiss, district engineer for Southern Bell Telephone Company, Montgomery, Ala., and chairman of the Montgomery Subsection.

Power Company, Birmingham; and B. B. Marsh, vice-president, Southern Division, Alabama Power Company, Montgomery, were among the many members and guests from Southern Bell Telephone Company and the Alabama Power Company in attendance at the meeting.

At the conclusion of the dinner, the group moved to an auditorium at the Air University to see an excellent electronic demonstration presented by C. N. Hoyler, manager of technical relations for RCA Laboratories, Radio Corporation of America. Mr. Hoyler was introduced by Col. P. T. Hanley, vice-commandant of the Air War College, Maxwell Air Force Base, after a welcoming address by Lt. Col. Herbert Herman. Mr. Hoyler's program entitled "New Adventures in Electronics," covered the field of electronics from picture transmission to manufactured electronic musical sounds.

Dinner Will Honor Recipient of Hoover Medal

Lt. Gen. R. A. Wheeler, who has been announced as the recipient of the Hoover Medal for 1958, will be the guest of honor at a special dinner meeting of The Society of American Military Engineers (S.A.M.E.) on February 19, 1959, when the presentation of the award will be made. He is a past president of S.A.M.E.

The Hoover Medal, the outstanding engineering award of the United States, has been offered annually since 1930 by the four founder engineering societies: American Society of Civil Engineers; American Institute of Mining, Metallurgical, and Petroleum Engineers; American Society of Mechanical Engineers; and AIEE. Walker Cisler, chairman of the Hoover Medal Award Committee, announced the selection for 1958.

Gen. Wheeler served in World War II as commander of the India–Burma Theater and Deputy Supreme Allied Commander of South East Asia Command; and as Chief of Army Engineers from 1945 until his retirement in 1949. Since then, he has been associated with the International Bank for Reconstruction and Development, initially as chief engineer and for the last few years as consultant. He was lent by the Bank to the United Nations to direct the clearance and rehabilitation of the Suez Canal, and later to set up a comprehensive plan for the watershed of the lower Mekong River in Southeast Asia.

A native of Illinois, Gen. Wheeler was graduated from the U. S. Military Academy in 1911, and commissioned in the Corps of Engineers. He served in the Army for 42 years including construction of the Panama Canal in 1911 and 1912; the Vera Cruz Expedition in 1914; and duty in World War I as commander of the 4th Engineer Regiment.

The dinner and presentation ceremony will be held on Thursday, February 19, 1959, in the East Room of the Mayflower Hotel, Washington, D.C., with Maj. Gen. E. C. Itschner, Army Chief of Engineers and President of S.A.M.E., presiding. Among the distinguished guests who have been invited are the Honorable Herbert Hoover, the members of the Hoover Medal Committee, the presidents and executive secretaries of the four founder societies, Eugene Black, president of the International Bank for Reconstruction and Development, and members of Gen. Wheeler's family.

Members of the founder societies and of the host society and their wives and friends are cordially invited to attend.

Reservations at $7.50 per person should be made at The Society of American Military Engineers, 808 Mills Building, Washington 6, D.C.

Call for Papers for Magnetic Amplifiers Conference

The fourth annual Special Technical Conference on Nonlinear Magnetics and Magnetic Amplifiers will be held September 23-25, 1959. The Conference is sponsored by the AIEE Committee on Magnetic Amplifiers and the Institute of Radio Engineers (IRE) Professional Group on Industrial Electronics.

The technical program will consist of sessions devoted to the theory, design, and application of: (A) magnetic amplifiers and similar saturating core devices, (B) magnetic amplifiers and semiconductor devices in circuit combinations, and (C) magnetic components for switching circuits and digital computers.

Authors are invited to submit abstracts of papers to the Technical Program Chairman, F. G. Timmel, 4601 Forest Park Ave., Baltimore 7, Md., by February 1, 1959. Abstracts should be 200 to 400 words in length. Final manuscripts must be submitted by June 22, 1959. Papers may be submitted for the Conference only or for AIEE Transactions status as well. All papers will be published in the Conference Proceedings which will be available at the meeting.

A number of invited papers by international authorities in the area of nonlinear magnetics will supplement the technical program.

An additional feature of the Conference will be exhibits by leading manufacturers of cores, semiconductor devices, magnetic amplifiers, and associated apparatus. The exhibits will be available for inspection during the 3-day conference.

The membership of the sponsoring committee is as follows: *Steering Committee*—D. Feldman, chairman, Bell Telephone Laboratories, West Street, N. Y.; V. J. Louden, General Electric Company, Schenectady, N. Y.; G. F. Pittman, Jr., Westinghouse Electric Corp., Pittsburgh, Pa.; *Technical Program*—F. G. Timmel, chairman, Westinghouse Air Arm. Division, Baltimore, Md.; *Publications*—W. C. Bullock, chairman, G-L Electronics, Camden, N. J.; *Publicity*—E. J. Alexander, chairman, Bell Telephone Laboratories, Whippany, N. J.; *Local Arrangements*—C. W. Lufcy, chairman, Dynacor, Inc., Kensington, Md.; *Exhibits*—A. Magagna, Westinghouse Electric Corp., 10 Collins Ave., Pittsburgh, Pa.; *AIEE Headquarters*—

Michigan Section Member Honored

A. P. FUGILL (*right*), chief electrical engineer, Electrical Engineering Division, planning and project engineering department, Detroit Edison Company, was presented with "A Certificate of Recognition" at the AIEE Michigan Section meeting of November 11, 1958, held at the Detroit Edison River Rouge Power Plant. Mr. Fugill received the award from Section Chairman J. W. Eakins (*left*) in recognition of his many contributions to the Michigan Section, and in particular for his outstanding work in reorganizing the Section during his tenure as Section Chairman 1952-53. The reorganization has greatly facilitated the recent rapid expansion of the Section, both in membership and activities. The November meeting, also honored by the presence of Walker Cisler, president of the Detroit Edison Company, included a tour of the new River Rouge Power Plant. Over 250 members and guests were in attendance.

R. S. Gardner; *IRE Headquarters*—L. G. Cumming.

Additional information may be obtained by writing to: E. J. Alexander, Bell Telephone Laboratories, Whippany, N. J.

Professors Win District Paper Competition

Dr. G. V. Lago, professor of electrical engineering at the University of Missouri, and Dr. C. R. Hausenbauer, an alumnus of the University and now professor of electrical engineering at the University of Arizona, have been awarded first place in the Southwest District Prize Paper Competition of the AIEE.

The award was made for a joint paper by Dr. Lago and Dr. Hausenbauer titled "Synthesis of Control Systems Based on an Approximation to a Third-Order System," which they presented at the 1958 AIEE Summer General Meeting.

Presentation of the award to Dr. Lago was made November 13 at a joint meeting of the St. Louis Section of AIEE and the St. Louis Engineers' Club, at Washington University, St. Louis, Mo. It was presented by I. T. Monseth of Westinghouse Electric Corporation, AIEE vice-president for District No. 7.

The work on which the paper was based was carried out on a research grant from the National Science Foundation. Dr. Lago was chief investigator of the research project.

Dr. Hausenbauer received his Ph.D. degree in electrical engineering from the University of Missouri in 1957. He also holds a B.S. and a M.S. degree from the University.

Science Lecture Program Well Received by Public

The Kansas City Section of AIEE has completed a series of four lectures designed for the general public on the Science of Electricity. These lectures, presented as a public service because of today's high interest in science, were entirely separate from regular Section business meetings as they were designed for the high school student, the science teacher, and the interested layman. The average attendance was 90 at each meeting.

The program was well received by the general public. All high schools and colleges in a 50-mile radius were contacted and expressed a great deal of interest. They distributed programs to their science teachers and student counselors who made up a large part of the audience for each meeting.

Credit should go to many other engineering organizations for their co-operation in announcing the lectures at their meetings, for sending copies of the program with their meeting notices, and to two organizations who published the complete program in their monthly magazines. Notices were also carried in the newspaper and announced over the radio stations. About 10,000 programs describing the entire series of four lectures were printed and distributed in advance for publicity. The meetings were held in the auditorium of Linda Hall Technical Library.

In the four lectures, an effort was made to cover the entire field. The first lecture was on basic electricity and history. The following three lectures were on more specific applications in the three main fields of communications, electronics, and power. Each lecture was given by a specialist in his field and a great deal of credit for the success of the meetings belongs to the lecturers for the time and effort they spent in preparing their material for presentation to an audience of laymen.

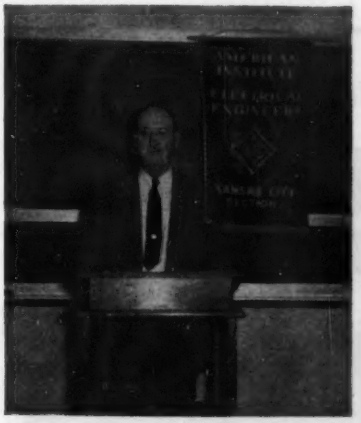
Final Plans for Textile Industry Conference

The Textile Industry Subcommittee of AIEE has made the final arrangements for its Conference, to be held April 2-3, 1959, in Atlanta, Ga., at the Heart of Atlanta Motel.

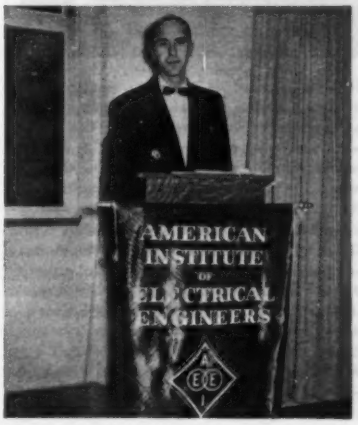
This Conference is designed to bring before managers, engineers, technicians, and master mechanics of the textile industry, information concerning application of new equipment and discussion of operational problems of new equipment. This is the only conference of its kind in the Southeast and through it people are kept informed of electrical developments that have an impact on the textile industry and solve many of the industry's problems.

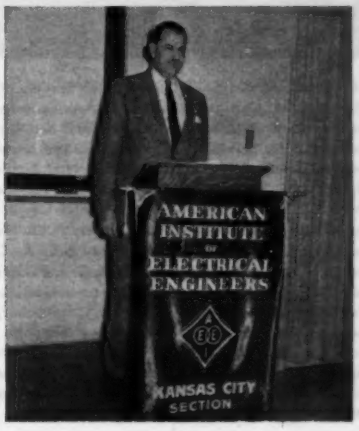
The following seven papers are scheduled to be presented:

1. "What Brush Should I Use for Better Commutation?" To be presented by the Stackpole Carbon Company.
2. "Semiconductors and How They Work." To be presented by the Westinghouse Electric Corporation.
3. "Application of Semiconductor Drives in the Textile Industry." D. C. Beck, senior engineer, General Electric Company.
4. "Is Your Electrical Equipment Safe?" Guy Booker, safety supervisor, Chemstrand Corporation.
5. "The Disease Called Power Factor



THE KANSAS CITY SECTION OF AIEE recently completed a series of four lectures designed for the public on the Science of Electricity. Speakers and their topics were: Prof. R. M. Kerchner (above, *left*), head of the department of electrical engineering, Kansas State College, "Electricity"; L. M. Hartwell (above, *right*), fundamental plans engineer, American Telephone & Telegraph Company, "Communications"; Dr. J. N. Warfield (below, *left*), associate professor of electrical engineering, University of Kansas, "Electronics"; C. M. Lytle (below, *right*), manager of operations, Kansas City Power & Light Company, "Power."



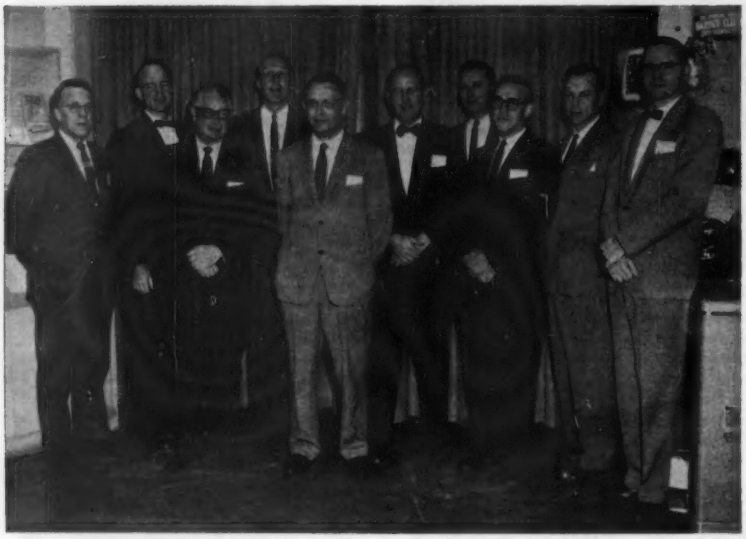


AIEE Fellow Diplomas Presented

AT THE annual dinner meeting of the Dayton Section of the Institute on October 14, Prof. F. A. Bordan (*left*) of the University of Dayton presented fellow diplomas to T. C. Lloyd (*center*) and E. P. Larsh (*right*), both of the Dayton Section. The presentation took place at The Engineers' Club of Dayton.

Courtesy Edmund M. Johnsey

Pittsfield Section Honors Members



SOME 11 MEMBERS of the Pittsfield Section of AIEE were honored at a regular meeting held November 4. Certificates of award were presented to newly elevated Fellows, to members who had written prize technical papers, and certificates of appreciation were presented to two members for their service to the Institute. The awards were presented to recipients by F. S. Bacon, secretary-treasurer of AIEE Northeastern District No. 12. Shown at the meeting are (*left to right*): A. F. Rohlfs, co-author, Third Prize Section Paper; J. C. Russ, chairman Subcommittee on Protective Devices; J. W. Seaman, Fellow; S. B. Williams, co-author, Second Prize Section Paper; co-author, Second Prize District Paper; D. D. MacCarthy, Fellow; Mr. Bacon; W. J. Cuthbertson, co-author, Second Prize Section Paper; B. A. Cogbill, past Section chairman; H. E. Fiegel,. co-author, Third Prize Section Paper; J. G. Anderson, co-author, First Prize Section Paper. Not present for the photograph: P. A. Abetti, co-author, Second Prize Section Paper and co-author, Second Prize District Paper; J. H. Hagenguth, co-author, First Prize Section Paper. Titles of the prize papers are: First Prize Section Paper—"Magnetic Fields Around a Transmission Line Tower"; Second Prize Section Paper—"Philosophy of Applying Digital Computers to the Design of Electrical Apparatus"; Third Prize Section Paper—"Impulse Flashover Characteristics of Long Strings of Suspension Insulators"; Second Prize District Paper—"The Practice in the Economics of Applying Digital Computers to Engineering Problems."

and How Capacitors Can Profitably Cure This Disease." H. J. Forbes, Celanese Corporation of America.

6. "New Techniques in Control Wiring Diagrams and Use of These Diagrams in Trouble Shooting." To be presented by Reliance Electric Corporation.

7. "Lighting for Inspection Processes." To be presented by Sylvania Electric Products, Inc.

This program will be presented from 10 a.m. to 5 p.m. Thursday and 9 a.m. to 12 Noon Friday. A social hour and banquet is planned for Thursday evening.

Trends in Earnings of Engineers, 1956-58

Engineers Joint Council has published the third report of its study series on Professional Income of Engineers initiated in 1953. The report presents the most comprehensive analysis of engineering earnings ever completed in the United States, including information on 190,810 engineering graduates in various employment activities.

The study concludes that earnings of engineers during the 1956-58 period continued their upward trend, observed in the previous survey interval of 1953-56. The over-all *median* (for all graduates, irrespective of experience) was $6,500 in 1953, $7,750 in 1956 (19% increase or about 6.5% annually) and $8,750 in 1958 (up 13% from 1956 or 6.5% average yearly). The latter represents an increase from mid-1956 to mid-1958. For the same 2-year span, the Consumer Price Index rose 15% and the average gross weekly earnings for production workers climbed about 10%.

The median salaries for engineering graduates by year of entry into the profession for various activities are given. Included are data for graduates in all activities combined, for those in industry, Government, engineering education, and for two industrial classifications that have significant employment of electrical engineers—electrical machinery and electronics manufacturing and utilities (over 42,000 engineers are included in the first and 10,000 in the second).

The survey includes information on annual income for medians, quartiles, and decile lines in over 41 tables and graphs for various activities. There are 25 industry breakdowns, 6 Government, and 9 for educators.

The report may be obtained from the Engineering Manpower Commission of Engineers Joint Council, 29 W. 39 St., New York 18, N. Y. at $3 a copy. Quantity discount on request.

Membership in the American Institute of Electrical Engineers, including a subscription to this publication, is open to most electrical engineers. Complete information as to the membership grades, qualifications, and fees may be obtained from Mr. N. S. Hibshman, Secretary, 33 West 39th Street, New York 18, N. Y.

Conference Papers Open for Discussion

Conference papers listed below have been accepted for AIEE *Transactions* and are now open for written discussion until February 26. Duplicate double-spaced typewritten copies of each discussion should be sent to E. C. Day, Assistant Secretary for Technical Papers, American Institute of Electrical Engineers, 33 West 39th St., New York 18, N. Y., on or before February 26.

57-1015 **Design of Random Noise Transformers.** *M. P. Vore*

58-117 **Magnet Wire for 600 C Temperature Transformers.** *W. W. Wareham*

58-188 **Factors Leading to the Development of Ceramic Hydrogen Thyratrons.** *H. N. Price, A. W. Coolidge*

58-234 **A Generalized Computer Procedure for the Design of Optimum Systems. Part I.** *R. R. Brown*

58-235 **A Generalized Computer Procedure for the Design of Optimum Systems. Part II.** *R. R. Brown*

58-879 **On the Anomaly in Residual Polarization of $BaTiO_3$ Ceramics.** *Y. Saito, S. Yamanaka*

58-1026 **Relay-Type Feedback Control Systems with Dead Time and Sampling.** *K. Izawa, L. E. Weaver*

58-1102 **A New Automatic Program for Load-Flow Studies on the IBM *704*.** *M. S. Dyrkacz, F. J. Maginniss*

Preprints may be purchased at 40¢ each to members, 80¢ each to nonmembers, if accompanied by remittance or coupons. Please order by number and send remittance to: AIEE Order Department, 33 West 39th St., New York 18, N.Y.

AIEE PERSONALITIES

Ernst Weber (AM '31, F '34), president of the Polytechnic Institute of Brooklyn and president of the Polytechnic Research and Development Corp., has been elected president of the Institute of Radio Engineers (IRE) for 1959. Dr. Weber was born in Vienna, Austria, on September 6, 1901. He received the Ph.D. degree from the University of Vienna in 1926 and the Sc.D. degree from the Technical University of Vienna in 1927. After working at the Austrian Siemens-Schucket company as research engineer, Dr. Weber was transferred to the Siemens-Schucket Company in Berlin in 1929. He was also appointed lecturer at the Technical University of Berlin. In 1930, he accepted a post as visiting professor at the Polytechnic Institute of Brooklyn and in 1958 was named president. During World War II, Dr. Weber organized a microwave research group which developed, among other things, the precision microwave attentuator, which is used for the accurate calibration of radar. In recognition of the contribution of the research group, he was awarded the Presidential Certificate of Merit. A pioneer in high-frequency electronic research, Dr. Weber holds more than 50 United States, Canadian, and British patents in the field of microwave techniques and has published many scientific papers and several books in this field. These qualifications also led to his being named a member of the Army Scientific Advisory Panel in 1957. Dr. Weber is a Fellow of the IRE and the American Physical Society. Dr. Weber has served on numerous Institute Committees including: Basic Sciences (1935-47); Research (1935-39); Charles LeGeyt Fortescue Fellowship (1942-48); Instruments and Measurements (1950-56, chairman 1955-56); Board of Examiners (1954-57); Science and Electronics Division (1955-58); Education (1956-58); Technical Operations Department (1956-58); Instrumentation Division (1956-58); Indicating and Integrating Instruments (1956-57); Special Instruments and Auxiliary Apparatus (1956-57); Electronic and High-Frequency Instruments (1956-57).

B. R. Teare, Jr. (AM '29, F '42), dean of engineering and science, Carnegie Institute of Technology, Pittsburgh, Pa., has been nominated for the office of president of American Society for Engineering Education (ASEE). Dr. Teare, who is AIEE vice-president for District No. 2. (1957-59), received his bachelor's and master's degrees from the University of Wisconsin. In 1929, he joined the General Electric Company as a student in the advanced engineering course. In 1933, he joined the faculty of Yale University. While serving as instructor, then assistant professor of electrical engineering, he received his D. Eng. degree in 1937. Dr. Teare joined the faculty of Carnegie Institute of Technology in 1939 and was named Buhl Professor of electrical engineering in 1943. He was appointed dean of the College of Engineering and Science in 1952. In 1947, he received the George Washington Award from the ASEE. He is a fellow of the Institute of Radio Engineers, and a member of Sigma Xi, Tau Beta Pi, Eta Kappa Nu, and Phi Kappa Phi. Dr. Teare has served on several Institute Committees including Communication, Electrical Machinery, Education, Edison Medal, and Professional Development and Recognition. He has also served as chairman of the Pittsburgh Section of the Institute.

J. H. Foote (AM '18, F '32), president and chief engineer of Commonwealth Associates, Inc., of Jackson, Mich., since its organization in 1949, has resigned his company position as president, continuing as chief engineer. He has also been appointed director of engineering for Commonwealth Services, Inc., parent company of the engineering firm, of which he also is a vice-president and a director. Mr. Foote served as AIEE vice-president for District No. 5, 1956-58, as a director, 1954-56, and on numerous Institute Committees.

J. R. North (AM '21, F '41), has been elected President of Commonwealth Associates, Inc., and also a vice-president of Commonwealth Services, Inc. He has been and will continue as executive engineer of Commonwealth Associates, Inc., and also as a director of Commonwealth Services. Mr. North has served as AIEE vice-president for District No. 5, 1950-52, as an Institute director, 1945-49, and has been active in AIEE Committee work.

M. C. Westrate (AM '37, F '58), consulting engineer, Commonwealth Associates, Inc., has been appointed chief electrical engineer. Mr. Westrate has served on the AIEE System Engineering Committee and was chairman of the Technical Program Committee for the 1958 Great Lakes District Meeting. He is currently a director of the Michigan Section. **F. E. Sanford** (AM '27, F '46), has been elected a vice-president of Commonwealth Associates, Inc., and is to direct business development. Mr. Sanford is currently president of the Michigan Engineering Society. He is past national president of Eta Kappa Nu.

C. H. LeVee (M '42, F '50), director of engineering and research, Hubbard and Company, Chicago, Ill., has been appointed vice-president of engineering, A. B. Chance Company, Centralia, Mo. Mr. LeVee is a member of the National Society of Professional Engineers and of the Society of American Military Engineers.

H. H. Kerr (AM '17, F '44, Member for Life), formerly vice-president of Toledo Edison Company, has become associated with Commonwealth Associates, Inc., Jackson, Mich., as a consulting engineer in connection with consulting and design engineering services for generating plants and operating systems. Mr. Kerr served as

AIEE vice-president for District No. 11 (1956-58) and has been a member of the Electrical Machinery Committee (1942-46). He has also served as a member of the Power Generation Committee of the Association of Edison Illuminating Companies. He is a fellow of the American Society of Mechanical Engineers.

F. W. Lowry (AM '57), assistant to the sales manager, aircraft equipment department, Westinghouse Electric Corporation, Lima, Ohio, has been named sales manager of the newly formed Space Technology Section. **N. F. Schub, Jr.** (AM '50, M '57), supervisory engineer in the aircraft engineering department, has been named engineering manager of the new section.

P. M. McCullough (M '51), vice-president, Automatic Electric International, retired October 31. He has been with the firm since 1944, planning and managing a wide range of projects in Europe, the Far East, Central America, and South America.

W. G. Shepherd (M '51), head of the University of Minnesota department of electrical engineering, has been retained as consultant by Control Data Corporation, Minneapolis, Minn.

T. M. Stout (AM '48), of Thompson-Ramo-Wooldridge Products Company, Los Angeles, Calif., has been named manager of the process applications department, Engineering Division. He served on the AIEE Feedback Control Systems Committee (1952-58).

J. S. Thompson (AM '14, F '38, Member for Life), president, Federal Pacific Electric Company, is the new honorary chairman of the firm. Mr. Thompson entered the electrical apparatus industry in 1906 when he founded Pacific Electric and Manufacturing Company in Napa, Calif. After this firm merged in 1954 with Federal Electric Products Company, he continued as president of the combined concerns. Mr. Thompson served on the AIEE Public Relations Committee (1952-55).

William Weisz (AM '49), has been promoted to product manager, two-way mobile and portable products, for Motorola's Communications and Industrial Electronics Division. He had been chief engineer.

Roland Whitehurst (AM '20, F '43) has retired as vice-president of The Electric Storage Battery Company, Philadelphia, Pa., after more than 50 years of service. Mr. Whitehurst joined the firm at the age of 15 in 1908 as an office boy in the New York branch. He is a member of many organizations, including the Materials Handling Institute, American Newcomen Society, American Society of Naval Engineers, The Franklin Institute, and National Association of Manufacturers. He has served as chairman of the Washington Section of the AIEE and as a member of the Institute's Board of Examiners (1950-52).

A. K. Alsaker (AM '39, M '50), assistant chief engineer of the Chicago, Ill., Works of Delta-Star Electric Division, H. K. Porter Company, Inc., has been advanced to chief engineer and will be in charge of all engineering at the Chicago Works. He has served on the AIEE Switchgear Committee (1956-59). **C. R. Billman** (AM '53), staff assistant of Delta-Star Electric Division in Chicago, has been transferred to Philadelphia, Pa., and appointed assistant manager of the Electric Service Works there. **R. W. Dixon** (AM '49), assistant manager of the Electric Service Works of Delta-Star Electric Division, has been appointed manager of the Electric Service Works in Philadelphia.

H. D. Bickley (AM '55), who recently completed Allis-Chalmers Manufacturing Company's training course for graduate engineers, has been assigned to the post of analyst, Engineering Analysis Section, at Allis-Chalmers West Allis Works.

L. R. Crane (AM '41, M '48), of the Anderson Electric Corporation, Birmingham, Ala., has been appointed sales manager of the Penn-Union Electric Corporation.

A. J. Erickson (AM '46, M '50), director of Armament Test Activity, Vitro Laboratories, a division of Vitro Corporation of America, has been named vice-president of Vitro Laboratories and general manager of Vitro Weapons Services at Eglin Air Force Base, Fla.

E. A. Goetz (AM '42, M '55), chief engineer of Arma Division, has been appointed technical assistant to the president of American Bosch Arma Corporation, Hempstead, N. Y. He will retain his position as chief engineer.

George Gumas (AM '52), of CDC Control Services, Inc., Hatboro, Pa., has been appointed vice-president in charge of engineering. Mr. Gumas will be responsible for the production of control systems, the development of new control techniques, and the scheduling of all engineering work.

W. T. Harding (AM '44, M '53), retired on December 1, 1958, as technical director of the Aeronautical Accessories Laboratory, Wright Air Development Center, Dayton, Ohio, after 33 years of service with the Air Force. He served on the AIEE Air Transportation Committee (1946-51, 1954-57).

K. A. Hoagland (AM '44), director of engineering for tube operations, Allen B. DuMont Laboratories, Inc., Clifton, N. J., has been appointed director of color tube research and development.

J. B. Angell (AM '47, M '58) has been named manager of circuit research, solid-state electronics research department, Philco Corporation, Philadelphia, Pa. Dr. Angell will be primarily responsible for circuit research with new solid-state elec-

New York Section Honors Past Officers

Courtesy Ross Photos

AMONG THOSE HONORED at a dinner sponsored by the AIEE New York Section, December 9, 1958, at the Engineers' Club in New York City, were past National Officers and Past Chairmen of Institute Departments, Committees, and Subcommittees. Shown are (*seated, left to right*): B. G. A. Skrotzki, past chairman, Prize Awards Committee; L. R. Montfort, past chairman, Wire Communication Systems Committee; AIEE President L. F. Hickernell, past treasurer, AIEE; W. J. Barrett, past president, AIEE; R. W. Gillette, past chairman, New York Section; S. W. Marras, past chairman, Standardization of Locomotive Wiring Diagrams Subcommittee; (*standing, left to right*): R. M. Franklin, past chairman, Navigation Equipment Subcommittee; F. C. Roberts, past chairman, Surveys Committee; H. I. Romnes, past chairman, Lamme Medal Committee; R. D. Campbell, past chairman, Radio Communication Systems Committee; J. L. Callahan, past chairman, Admission and Advancement Department; G. H. Needham, past chairman, New Jersey Division; and C. F. Savage, Jr., past chairman, Instrumentation Division.

tronic components in the development of very high-speed computer circuits and microwave devices. He has served on the AIEE Solid-State Devices Committee (1955-59).

N. G. Branson (AM '39, M '45), president, Branson Ultrasonic Corporation, Stamford, Conn., has been elected to the board of directors of the Ultrasonic Manufacturers Association.

R. L. Bobo (AM '54), general sales manager, Federal Pacific Electric Co., Newark, N. J., has been elected vice-president, marketing. **H. E. Knudson, Jr.** (AM '57), manager of the company's Middle Atlantic Sales Region, has been appointed general sales manager.

A. D. Brown (AM '31, M '45) regional representative, Philadelphia (Pa.) district, Allis-Chalmers Manufacturing Company, has retired from the company after 35 years of service. Mr. Brown served on the AIEE Membership Committee (1946-48).

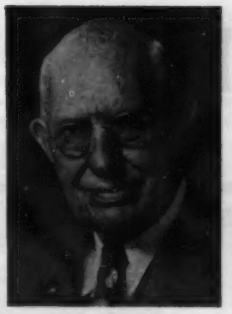
A. C. Westrom (AM '51, M '56 was appointed director of engineering, research and development, of Hubbard & Company, Chicago, Ill. Mr. Westrom has been with the Hubbard organization since 1950 as assistant director of research, also as director of research, electrical apparatus.

Nathan Cohn (AM '29, F '54), manager, Market Development Division, marketing department, Leeds & Northrup Company, has been named to the new post of vice-president, technical affairs. **D. E. Moat** (AM '29, M '39), director of marketing, has been named vice-president, marketing, while retaining his former function. Mr. Cohn is a member of the following AIEE Committees: Nucleonics (1956-59), Nuclear Congress and Nucleonics (1958-59), and Feedback Control Systems (1958-59). Mr. Moat has served on the AIEE Transfers Committee (1945-49, chairman 1946-48) and Recognition Awards Committee (1958-60).

A. W. Dawson (AM '49), formerly sales manager of the industrial bulb department, Corning Glass Works, Corning, N. Y., is now serving as manager of the company's electronic components department whose operations are centered in Bradford, Pa.

OBITUARIES

Charles Franklin Kettering (AM '04, F '14, Member for Life), internationally known inventor, engineer, and manufacturer, died recently at the age of 82. In 1956, the major engineering societies observed Mr. Kettering's 80th birthday by presenting him with the first Charles Franklin Kettering Award, which read "For pioneering inventions in the fields of applying materials and energy to practical uses, for stimulation of the inventive ideal in thousands of engineers and scientists, for contributions to our National Defense, for enlarging the co-operation between industry, research, and education, for enthusiastic selfless dedication to human relations and welfare, our societies have instituted The Charles Franklin Kettering Award and are now joined together to make this initial presentation to Charles Franklin Kettering." A director and former vice-president of General Motors Corp. and former general manager of the General Motors Research Laboratories, Mr. Kettering was born on a farm near Loudonville, Ohio, on August 29, 1876. After graduation from Ohio State University in 1904, he became associated with the inventions department of the National Cash Register Company at Dayton, Ohio, where he developed an electric drive for the cash register. In 1909, Mr. Kettering organized the Dayton Engineering Laboratories Company where he invented the electric starting, lighting, and ignition systems for the automobile. In 1916, he established a research laboratory at Dayton which was taken over by General Motors in 1920, at which time he began his lifelong connection with General Motors. Mr. Kettering received honorary degrees from over 30 colleges and universities, including University of Cincinnati, Brown University, New York University, Columbia University, Dartmouth College, Harvard University, Polytechnic Institute of Brooklyn, Worcester Polytechnic Institute, and Princeton University. He was the recipient of numerous medals and awards among which are the Washington Award, 1936; Franklin Gold Medal, 1936; American Society of Mechanical Engineers Medal, 1940; John Fritz Medal, 1944; Thomas A. Edison Award, 1945; Gold Medal of the International Benjamin Franklin Society, 1949; and National Society of Professional Engineers Award, 1953. Mr. Kettering held honorary and life memberships in numerous societies, including the National Academy of Sciences, Society of Automotive Engineers, The Franklin Institute, American Society for Steel Treating, American Philosophical Society, American Hospital Association, and Engineering Society of Cincinnati. Shortly before his death, he was named to receive the AIEE Edison Medal.



C. F. Kettering

Erik Floor (AM '45, M '45), founder and president of Erik Floor & Associates, Inc., Chicago, Ill., died recently at the age of 67. Mr. Floor was born in Copenhagen, Denmark, and was a graduate in electrical engineering of the University of Copenhagen. He was employed with A. G. Siemens-Schubert and the Danish State Railway before coming to the United States in 1919. Since that time, he had been active in the field of hydroelectric generation. He was associated with the late L. F. Harza, hydroelectric consultant, from 1921 to 1945, first as chief electrical engineer, and, after 1934, as vice-president and chief engineer of the Harza Engineering Company. In 1945, he formed Erik Floor & Associates which investigated and designed many projects both in the United States and abroad.

Marshall Edgar Lake (AM '23, M '31, Member for Life), vice-president, Duke Power Co, Charlotte, N. C., died recently at the age of 57. Mr. Lake was born November 26, 1900, in Washington, D. C. An electrical engineering graduate of the University of North Carolina, he was a member of Phi Beta Kappa and Tau Beta Pi. He was employed by Southern Power Co. (now Duke Power Co.) in 1922. In 1944, he was appointed manager of the industrial power department and in 1946 was named a director of the company. In 1954, he was made vice-president in charge of industrial sales, system planning, and operational engineering. Mr. Lake was a past president of the Charlotte Engineers Club and a director of the North Carolina Society of Engineers. He was an active member and past chairman of the North Carolina Section of the AIEE.

Robert Gordon Rescorla (AM '54), manager APED, hermetic motor department, General Electric Company, Holland, Mich., died recently. Mr. Rescorla was born in Grand Haven, Mich., on September 1, 1926. He received the B.S. degree in E.E. from Michigan State College in 1950. In that same year, he joined the General Electric Company as test engineer. He was appointed supervisor of the test engineering program in 1952 and development engineer in the hermetic motor department in 1953.

Bimonthly Publications

The bimonthly publications, *Communication and Electronic Applications and Industry* and *Power Apparatus and Systems* contain the formally reviewed and approved numbered papers presented at General and District meetings and conferences. The publications are on an annual subscription basis. Members may receive one subscription to any *one* of the bimonthlies for $2.50. The balance of the annual $5.00 subscription price will be paid by application of his annual dues for the year of the subscription. (Members may not reduce the amount of their dues payment by reason of nonsubscription.) Additional member subscriptions will be at the rate of $5.00. Nonmembers may subscribe on an advance annual subscription basis of $8.00 each (plus 50¢ extra for foreign postage payable in advance in New York exchange). Single copies, when available, are $1.50 each. Discounts are allowed to libraries, publishers, and subscription agencies.

OF CURRENT INTEREST

SCIENTIST and observer conducting test with Discomfort Glare Evaluator apparatus to help determine the effects of light on human eyesight. Visual research specialist J. F. McNelis (left) instructs observer to match brightness of test spot to that of room illumination at GE Lamp Research Center.

Better Light Sources Probed in New Lamp Research Center

AN INTENSIVE PROGRAM aimed at "advancing the frontiers of knowledge of light production and its effect on all living things," was launched with the recent dedication of the new multimillion-dollar Lamp Research Center of the General Electric (GE) Lamp Division at Nela Park, Ohio.

CRYSTAL STRUCTURE secrets are probed by X-ray measurement device. Research structural analyst, J. R. Cooper, uses the diffraction unit to "blueprint" the way crystals are built. No two kinds of crystals are ever alike in structure.

Fundamentals Pursued

The manager of this newest GE research facility, C. L. Olson, said it was built to house an organization of research people who will not be bound by current thinking as regards the source, form, fabrication, operation, and application of light. It was also pointed out that this isolation from pressing production problems will enable the researchers to concentrate on the aggressive pursuit of fundamental knowledge and information.

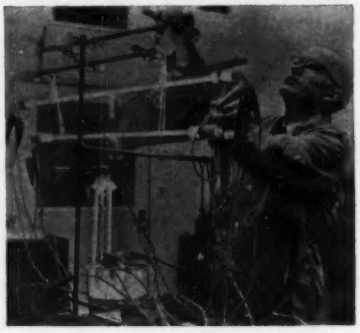
Special Preview

In essence, the GE Lamp Division has created an ultramodern monument to pure research which may very well be the source from which major lighting developments of tomorrow will spring, he declared.

As part of its dedication program, the Lamp Division invited the nation's top science editors and writers to Nela Park for a special preview of the giant new laboratory.

The Lamp Research Center houses three distinct research and engineering laboratories linked by a common objective—the searching out of better lighting and light sources. They are: (1) the Lamp Research Laboratory, (2) the Lamp Engineering Research Laboratory, (3) the Radiant Energy Effects Laboratory.

The Lamp Research Laboratory, under the direction of Dr. J. S. Saby, is involved chiefly in scientific investigation



MERCURY VAPOR causes a glow to pulse up and down through the length of tubes as mrecury ions seek the glass wall. Neutral mercury atoms then come off to restart the cycle. Phenomenon is so new, it has no name as yet. Consulting physicist Dr. Carl Kenty hopes to be able to point engineers in the direction of better fluorescent lighting.

into chemical and physical processes which give off light.

This team covers the entire field of materials important to the lamp business. Its interest also extends to the chemical synthesis of new materials better than those found in nature which may be of future value in creating new light sources.

The Lamp Engineering Research Laboratory is under the direction of D. E. Elmendorf, a veteran of 30 years in engineering with GE's Lamp Division.

This member of the research triumvirate is concerned with the interpretation of scientific research findings and translating them into sound engineering practices. It is a connecting link between pure science and the practical considerations involved in producing a new product.

Elmendorf's staff is often called on to come up with new inventions needed for new product processing. It is not uncommon for this group to investigate and give counsel on the necessary material, instrumentation, and new chemical and mechanical processes needed for producing a new product.

Third member of GE's research powerhouse is the Radiant Energy Effects Laboratory, which is under the direction of S. K. Guth. Mr. Guth has carried on his work in lighting research on a worldwide scale and is the author of many scientific and technical papers outlining the criteria and techniques he has developed in his field.

Objectives and Effects

The Radiant Energy Effects Laboratory staff is engaged in the investigation of the effects of light chiefly on man, but also on plants and animals. The "effects" it deals with embrace physiological, psychological, and psychophysical reactions of living things when exposed to light.

Its prime objective is to obtain a better understanding of how and why people see better with improved lighting.

The creation of this new research facility is in keeping with the Lamp Division's long established policy of using the sciences to advance the lighting industry, Olson pointed out. Recognized as the leading research organization in the industry, the Lamp Division has led the way in most of the major developments in lighting and light sources over the past four decades, he said.

Missile and Satellite News Items

Polaris Missile Human Engineered. A Lockheed Missile Systems Division human engineer told a submarine and space medicine symposium in New London, Conn., that research into factors affecting human survival under prolonged submerged cruise conditions is directly affecting his company's design of the U.S. Navy's *Polaris* fleet ballistic missile. Dr. J. W. Wissel, a senior engineering psychologist on the *Polaris* program at Lockheed's Sunnydale, Calif., plant said that his staff is investigating all materials proposed for inclusion in the 1,500-mile-range missile, for possible toxic effects under normal or emergency conditions. If, for example, research indicates that a certain substance might cause toxic fumes in the carrying submarine's atmosphere in event of an electrical fire or exposure to sea water, then an all-out effort is made to substitute another material. Nowhere is Lockheed–Navy co-ordination closer than on the human factors question, Dr. Wissel said. Very early in *Polaris* development, the Human Factors Committee of the Special Projects Office pointed out that certain materials which might be innocuous over a short period of time could become potentially toxic air pollutants when closed up for prolonged periods. Therefore, the Special Projects Office set up a medical advisory committee, with representatives from the Navy's Bureau of Medicine and Surgery, the Naval Medical Research Laboratory at New London, and other Naval agencies to inaugurate a system to list items which were probably going to be used in design of the *Polaris* missile. This system has five main steps: (1) All items of material and components which are to be used—or which may be used in the future—are inventoried. (2) A general screening for potentially toxic material, using ground rules provided by the Special Projects Office are made. (3) A list of items which are not eliminated is passed on to the Special Projects Office. (4) Special Projects, using the resources of the Naval medical laboratories, conducts a more intensive screening which may require an extensive toxicological research program. (5) The toxic potential of identified materials and components is relayed to Lockheed and, whenever possible, a nontoxic substitute will be used in the missile design. If it is not possible to use a substitute, adequate personnel safeguards will be incorporated into the missile system.

Probe Upper Air with Rockets. A flying weather-sensing system "designed to probe the atmosphere on a global scale" is under development for the U. S. Air Force in a development program for airborne weather stations. The program, officially designated the *AN/AMO 15* Air Weather Reconnaissance System, is to be conducted by the Systems Division of Bendix Aviation Corporation, said Dr. R. D. O'Neal, divisional general manager. The "stations," consisting of 4-engined Air Force jets equipped with multiple radars, instrument-packed rockets, atmospheric sensing equipment, and electronic computers, will be in continuous communication with ground stations that will process and relay weather data over a national network, Dr. O'Neal said. Boeing Airplane Company will be a principal associate in getting this

Future Meetings of Other Societies

ASTM, Committee Week, Feb 2-6, William Penn Hotel, Pittsburgh, Pa. ASTM, 1916 Race St, Philadelphia 3, Pa.

SPI, Reinforced Plastics Division, 14th Annual Technical & Management Conference, Feb 3-5, Edgewater Beach Hotel, Chicago, Ill. SPI, 250 Park Ave, New York, N. Y.

Home Improvement Products Show (HIPS), Feb 4-6, Coliseum, New York, N. Y. Ted Black Agency, Medical Arts Bldg, Reading, Pa.

National Electrical Week, Feb 8-14. The National Electrical Week Committee, 290 Madison Ave, New York 17, N. Y.

National Rural Electric Cooperative Association, Annual Meeting, Feb 9-12, Shoreham Hotel, Washington, D. C.

ISA, 5th Annual Symposium on Instrumental Methods of Analysis, May 18-20, Shamrock-Hilton Hotel, Houston, Texas. *Abstract deadline:* Feb 15. M. D. Weiss, Special Instrumentation Div, Union Carbide Olefins Co, South Charleston, W. Va.

The Institute of Radio Engineers

National Symposium, Professional Group on Microwave Theory & Techniques, June 1-3, Div of Applied Physics, Harvard University, Cambridge, Mass. *Deadline for papers:* Feb 15. IRE, 1 E 79 St, New York 21, N. Y.

3rd National Convention on Military Electronics, June 29–July 1, Sheraton-Park Hotel, Washington, D. C. *Abstract deadline:* Feb 15. L. R. Evringham, Radiation, Inc, Orlando, Fla.

AIME Annual Meeting Feb. 15-19, Hotels St. Francis, Sheraton-Palace, Sir Francis Drake, San Francisco, Calif. AIME, 29 W 39 St. New York 18, N. Y.

AES, West Coast Convention, Feb 17-20, Biltmore Hotel, Los Angeles, Calif. AES, PO Box 12, Old Chelsea Station, New York 11, N. Y.

Pennsylvania Electric Association, Winter Meeting, Electrical Equipment Committee, Feb 19-20, Benjamin Franklin Hotel, Chestnut at 9th St., Philadelphia, Pa. F.W.A. Myers, Philadelphia Electric Co, 900 Sansom St., Philadelphia 5, Pa.

NSPE, Winter Meeting, Feb 19-21, Dinkler-Tutwiler Hotel, Birmingham, Ala. NSPE, 2029 K St, NW, Washington 6, D. C.

2nd National Lighting Exposition, Mar 1-4, Coliseum, New York, N. Y. National Lighting Expositions, 550 5th Ave, New York 36, N. Y.

American Management Association, Special Electronics Conference, Mar 2-4, Statler Hotel, New York, N. Y. AMA, 1515 Broadway, Times Square, New York 36, N. Y.

SFSA, 57th Annual Meeting, Mar 9-10, Drake Hotel, Chicago, Ill. G. K. Dreher, SFSA, 606 Terminal Tower, Cleveland 13, Ohio.

IAS, Flight Propulsion Meeting (Classified), Mar 19-20, Hotel Carter, Cleveland, Ohio. IAS, 2 E 64 St, New York 21, N. Y.

Overseas

8th Electrical Engineers' Exhibition, Mar 17-21, Earls Court, London, England. Electrical Engineers Exhibition Ltd, Assoc of Supervising Electrical Engineers, 6 Museum House, 25 Museum St, London, WC 1, England.

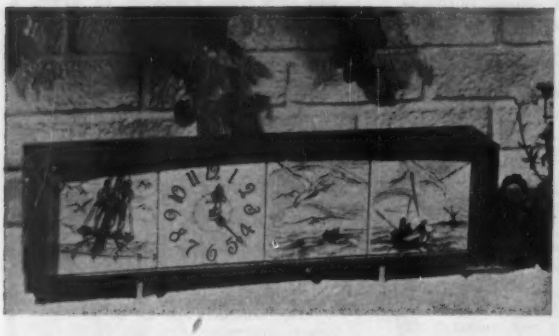
Engineering, Marine, Welding, and Nuclear Energy Exhibition, Apr 16-30, Olympia, London, England. Apply: F. W. Bridges & Sons Ltd, Grand Bldgs, Trafalgar Square, London WC 2, England.

The Institution of Electrical Engineers

Convention on Thermonuclear Processes, Apr 29-30, London, England. W. K. Brasher, IEE, Savoy Place, London, WC 2, England.

International Convention on Transistors & Associated Semiconductor Devices, May 25-29, Earls Court, London, England. Industrial & Trade Fairs Ltd, Drury Hse, Russell St, WC 2, London, England.

Single Battery Powers Clock



POWERED by a single leakproof flashlight cell, this beautiful fruitwood clock with attractive nautical tiles has decorator styling to fit into any home. Called the "Vista," it is manufactured by Seth Thomas Division of General Time. The single Ray-O-Vac flashlight cell operates the clock for more than a year. In addition to eliminating unsightly, dangling electrical cords, the 1.5 volt, size "D" battery power is inexpensive. The battery-operated clock needs no winding. A replacement cell costs only 20¢.

extended weather knowledge. The airborne weather system will be designed to operate in jet aircraft flying at Mach 0.95 (just under the speed of sound) at an altitude of 50,000 feet. The weather reconnaissance jets, which will make 4,500-mile flights, will measure cloud formations and look inside storms with radar sweeps extending 150 miles from the aircraft. At periodic intervals. radiosondes, or instrument-equipped units that radio information back to the aircraft, will be launched by rocket to probe the jet stream and other atmospheric phenomena.

Interplanetary Communications. Communication between the Earth and Mars is well within reach, W. F. Main, manager of the Electronics Research Division of Lockheed Missile Systems Division of Sunnyvale, Calif., told a meeting of the American Rocket Society and Institute of Radio Engineers. He said it is "fairly obvious" that the moon now is within radio communication range, it would take "little extension of present techniques" to be able to communicate with a space vehicle in the neighborhood of Mars, which is some 35 million miles away at its closest approach. To attain this interplanetary range, Mr. Main said, would demand a 20,000 times increase in transmitter power over that required to communicate with the moon which would result in "a clearly unreasonable power level." But significant extensions of range could be achieved without a proportional increase in power, he said, by utilization of a narrower bandwidth for the communication link. "The ground-to-satellite link must operate within the limitations of the atmosphere," he said, "but the frequency of the link between the space vehicles can be as high as desired, for example, at optical (light) frequencies."

Space Radiation Investigations. The intense band of radiation discovered by the Explorer satellites last summer will not keep men from going into space. Dr. Hubertus Strughold, professor of Space Medicine at the Air Force School of Aviation Medicine, made this statement at a recent symposium. The newly founded radiation, starting at about 350 miles above the Earth, will, however, require careful study by specialists in space medicine, Dr. Strughold said. The U.S. Air Force expert has just returned from the Congress of the International Astronautical Federation in Amsterdam, Holland, where the radiation hazard was a topic of concern to men who are planning the conquest of space by human beings. Since this band of intense radiation was discovered, some scientists have said it is severe enough to prevent men from surviving flight through it. As yet, there has been no definition of its ultimate intensity nor the full extent of the field. Dr. Strughold said that additional data given in San Antonio at the 2nd International Symposium on the Physics and Medicine of the Atmosphere and Space would be significant. Dr. Strughold also called for a "space geography" which would describe the extent of this and other physical conditions affecting space flight in the neighborhood of celestial bodies, including the Earth.

Aerodynamics of Supersonic Flight. A North American Aviation *XSM-64* guided missile was launched at Cape Canaveral, Fla., recently as part of a U.S. Air Force research program. Developed by the company's Missile Division, the missile is one of several to be flown under the RISE (Research in Supersonic Environment) program. RISE will gather information on aerodynamics and other aspects of supersonic high-altitude flight, in support of the *B-70*, Mach 3 long-range strategic bomber now under development at North American's Los Angeles Division. Findings should also be applicable to other advanced programs. The *B-70* is the only advanced intercontinental bomber currently under development for the Strategic Air Command (SAC). It will provide SAC with a manned weapon system which cruises at speeds exceeding 2,000 mph at altitudes above 70,000 feet.

British Air League Places Commemorative Plaque

A memento of aviation's historic past dropped out of the sky at Idlewild International Airport, New York, recently in the big blue and silver British Overseas Airways Corporation (BOAC) *Comet IV* jet airliner. It was a 2-foot-square bronze plaque destined for Roosevelt Field, L.I., N.Y. to mark the site of the first east-to-west and roundtrip crossing over the Atlantic by the British airship *R-34* nearly 40 years ago.

Donated by the Air League of the British Empire, the plaque will be set in place on the lawn of the Arma Division plant of American Bosch Arma Corporation at Foosevelt Field. The site and erection costs are being sponsored by American Bosch Arma Corporation after local historians determined that the Arma plant occupied the approximate spot where the *R-34* touched down July 6, 1919.

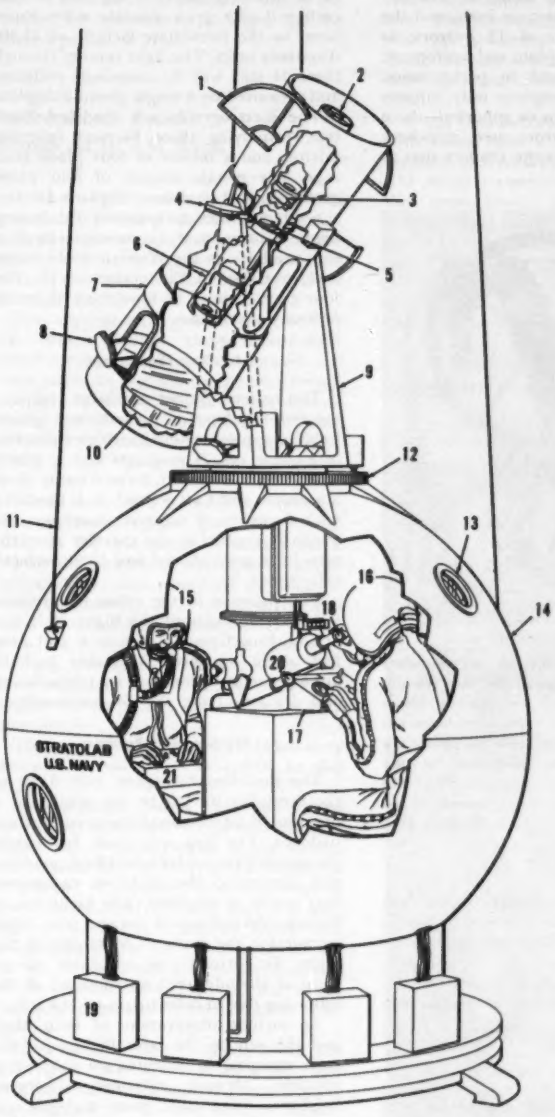
In striking contrast to the brisk 8-hour plus flight of the COAC *Comet IV*, the westerly flight of the pioneering *R-34* took over 108 hours and the return trip to England slightly more than 74 hours.

Built in Scotland, the *R-34* and its crew of 33 with one stowaway left East Fortune, Scotland, on July 2nd. After arrival at Roosevelt Field on July 6th, the officers and crewmen were feted in New York City for two days, then departed July 9th, 1919, and arrived in Bulham, England, on July 12th, 1919.

Selection of Arma was an appropriate choice, as this division of American Bosch Arma Corporation is under contract by the U. S. Air Force for the production of fire control systems for the *B-52* Stratofortress bomber and inertial navigation systems for long-range Air Force ballistic missiles. Other products for the Armed Force include ground support equipment, subminiature gyroscopes and torpedo fire-control systems for the Navy's atomic submarines afloat and under construction.

Star Tracker To Be Used in Study of Mars

IN EARLY NOVEMBER, Mars was approximately 45 million miles away from Earth. At that time, it was closer to Earth than it will be again for the next 17 years. Seventh in size, Mars is the fourth closest planet to the sun. Earth, fourth largest of the planets, is third from the sun. Mars is 4,399 miles in diameter, Earth 7,918 miles in diameter.



1. Sun filter
2. Star tracker (Cassegrain telescope)
3. Star tracker image sensor
4. Acquisition mirror no. 2
5. Monocenter mirror
6. Relay telescope
7. 16-inch Schmidt telescope
8. Acquisition mirror no. 1
9. Telescope mount
10. 16-inch Schmidt primary mirror
11. Supporting shrouds
12. Azimuth drive
13. Observation port
14. 7-foot gondola
15. Balloonist
16. Astrophysicist
17. Control panel
18. Target eyepiece
19. Batteries
20. Acquisition eyepiece
21. Coarse control panel

In many aspects, Mars has long been the most controversial of our planetary neighbors. The noted astronomer, Percival Lowell (1855-1916), aroused a storm of scientific debate when he described markings on the planet as a system of canals which, he inferred, must have been the handiwork of intelligent life forms.

H. G. Wells, famous English author, furthered the theory in his fictional "War of the Worlds" upon which Orson Welles based his famous broadcast in 1939 that touched off a panic on the Eastern Seaboard.

The controversial Willy Ley, well-known writer and lecturer on scientific subjects, has ventured the opinion that the red-color of Mars is caused by oxidation. On that assumption, he asserts there can be no free oxygen in any possible atmosphere Mars may have, and never will be.

It is the concensus, however, that the seasonally enlarging and contracting circles observed at both poles of Mars are frozen water.

All of these contradictory theories and views add significance to the postponed flight of Dr. Strong and Commander Ross in their balloon-borne Mt. Palomar of the sky. At 80,000 feet, their telescope will transcend all others, even Mt. Palomar's 200-inch, in its power to answer questions that have baffled man over the centuries.

Dr. Strong, nationally and internationally renowned for his studies of infrared rays, who initially proposed the flight, is now charged with obtaining the data. With the aid of a telescope, he will attempt to determine the presence or absence of water in Mars' atmosphere by spectroscopic study.

Although relatively small, the telescope performs on a scale far out of proportion to its size, because it is operating above the optical disturbance of Mars' image caused by air turbulence and is also above all attenuation of Mars' radiation by the heavy concentrations of gases, vapors and dust in the Earth's lower levels of atmosphere. With this advantage, the small telescope is able to obtain results denied to even the largest sky gazers on the ground below.

The telescope is mounted on the top of the balloon's gondola. This small sphere of aluminum, only 7 feet in diameter, hangs at the end of four thin strands of nylon rope 200 feet below the gas bag itself.

The smallest movement of the men or equipment in the gondola causes reactive motions that would normally prevent holding Mars in the telescope's field of observation for the period required to complete a satisfactory spectroscopic recording.

The Star Tracker

An ingenious device to overcome the torsional pendulum effects, resulting from necessary movements of the men in adjusting the telescope to Mars' travel during a period of several hours and conducting other equipment operations, was suggested by Dr. Strong and executed by Librascope, Incorporated, Glendale, Calif.

It consists of a complex, but exceedingly precise, star tracker. Despite movements of the gondola, this device will lock on Mars and hold the image generated by the main telescope on a spectrometer slit during the scheduled three hour analysis period. The star tracker accomplishes this to within one second of arc. This is to an accuracy of 1 part in 1,296,000 of a circle. It is this hitherto unattainable image stability that has made the new series of astral explorations feasible.

The entire viewing system consists of two telescopes—the large 16-inch reflecting telescope with an 18-inch focal length, and a small 3-inch diameter Cassegrain telescope centered in the forward end of the large telescope's barrel. A third optical relay system is pointed down the barrel toward the reflecting mirror of the large telescope. Another optical relay system is employed as a visual finder for the initial lock on, but as soon as that is accomplished it is nonessential to the tracking for astronomical observation.

The technique developed by Dr. Strong and implemented with a star tracking mechanism designed and built by Librascope eliminates the need for maintaining the position of the Schmidt telescope closer than 3 degrees of the arc.

Although, in Dr. Strong's system, the Schmidt telescope needs to maintain Mars only within its 3-degree field of view, the star tracker controlled optics holds the image of Mars, generated by the Schmidt telescope, on the spectrometer slit to within 1 second

of arc. This is possible because the spherical image surface generated by the 16-inch primary mirror is exactly concentric with the surface of the mirror. The center or curvature of both the mirror surface and coincident image surface is defined as the monocenter of the optical system. A small relay optical system, located within the Schmidt telescope, pivots about this monocenter. It is always aimed at the image of Mars as it appears in the Schmidt image surface, and relays the Mars image to the monocenter from which the light is further reflected and focused on the aperture of the spectrometering system. A tiny mirror at the monocenter must be actuated to do this, but the precision of this actuation is easily accomplished since errors of angle cause vignetting rather than image motion.

The star tracker is mounted coaxially with the relay telescope with its light gathering and sensing elements pointed out toward space. When the tracking device has locked on Mars, the relay system which views the area of the Schmidt image surface line with the axis of the tracking telescope, but opposite in direction, is pointed directly at the image of Mars.

Within the star tracker, light from Mars is focused by a Cassegrain telescope on a photomultiplier tube. A rotating semicircular shutter placed in front of the photomultiplier tube modulates the light so that when the image of Mars is not directly centered on the tube the light beam will be interrupted and an alternating voltage will be generated by the tube. When the tracking telescope is aligned with Mars and the image falls directly on the center of the tube, the tube will receive a constant quantity of light and a constant value of voltage will be generated by the tube.

The motor, which rotates the semicircular shutter, also drives a resolver. The output of the photomultiplier tube is also fed to the resolver. In this manner, the resolver determines the position of the Mars image with respect to the optical axis.

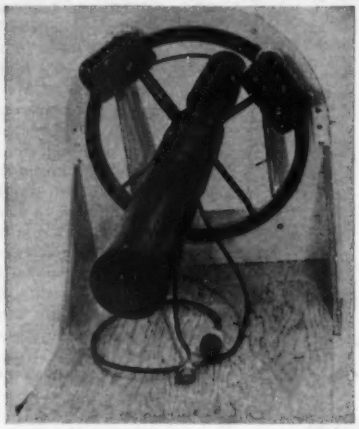
The outputs of the resolver in elevation and azimuth components are fed to elevation and azimuth actuators which pivot the tracking telescope about the monocenter and align the telescope with Mars. Whenever the image is not so positioned, signals generated by the photomultiplier tube actuate elevation and azimuth drive mechanisms to position the telescope correctly.

In operation, the Schmidt telescope (manufactured by Ferson Optical Co., Ocean Springs, Miss.) is positioned roughly on Mars by the operator by means of azimuth and elevation drives which rotate the Schmidt telescope directly.

Design of the complementary optical systems required to relay the image generated by the Schmidt system to the spectrophotometric equipment, was complicated by the wide range of wave lengths to be analyzed. This range extended from the visible spectrum required for initial acquisition and focusing, to the specific infrared spectrum to be measured by the spectrophotometric equipment.

The design of these complex optical systems was greatly accelerated through the use of an *LPG-30* electronic digital computer. A special computer permits mathematical evaluation of optical system performance in terms of aberrations which represent deviations of the actual image from the image derived, assuming perfect mirrors and lenses.

The precise nature of the measurements to be conducted in the Mars atmosphere analysis required maximum optimizations of optical system performance. The entire optical system, including the star tracker optics, the telescope itself, and the spectrograph, consists of 13 mirrors, as well as one corrector plate and achromatic lens. Diffraction-limited in performance, the optical system employs only mirrors which are either plain or spherical—there are no aspheric mirrors used anywhere within this system, despite the fact that at



STAR TRACKER, mounted in a temporary frame prior to installation at the Schmidt telescope barrel, shows the opening (foreground) through which light from Mars enters. Motions in azimuth and elevation are controlled by actuators mounted on the frame. The star tracker locks on Mars and maintains position within one second of arc —an accuracy of 1 part in 1,296,000 of a circle.

one point in the optical system the *f* ratio is 1.4. Use of the *LPG-30* program greatly shortened the time required to evaluate any one specific optical system, and permitted consideration of a number of design approaches to reach optimum performance.

Recording System

In the infrared recording system, the photographic plate has been replaced by a photoelectric cell which is a 16-stage multiplier photocell sensitive in the infrared and equipped with a ⅛ inch photocathode. This is an advantage, because the smaller the photocathode used, the higher the signal-to-noise ratio.

The recent availability of electronic detectors, such as the photomultiplier and the gold-doped germanium phototransistor, are opening possibilities of taking measurements in the infrared (to 8 microns) without the use of photographic methods.

The information comes out of a photocell to a conventional electronic amplifier and is recorded on a moving pen and ink recorder. The photocell itself is cooled by dry ice to enhance the signal-to-noise ratio.

There are a large number of water vapor absorption bands in the immediate vicinity of 11,300 Angstrom units. In this installation, the exit slit of the spectrophotometer will be replaced by a complex of 14 slits very carefully adjusted so that each will pick up a separate water vapor band in the immediate vicinity of 11,300 Angstrom units. The light coming through these 14 slits will be commonly collected and measured by a single photomultiplier.

The spectrograph is a modified Ebert type employing three Farrand spherical mirrors and a mosaic of four plane gratings. The mosaic consists of four plane gratings ruled at Johns Hopkins University on machines designed by Dr. Strong. These are the finest and most precise gratings available in the Western world today, and probably in the entire world. The four gratings must be lined up with extraordinary precision.

Auxiliary Equipment

The balloon proper is a large compartmented envelope of polyethylene plastic holding approximately 2 million cubic feet of helium gas. The gondola is a sphere only 7 feet in diameter, formed out of sheet aluminum and butt welded. It is insulated with 6 inches of crushed aluminum foil which is applied to the exterior after the men have gone aboard and been hermetically sealed in.

The pressure in the cabin will remain the same throughout the flight as it was at launching from Rapid City, S. Dak., 400 feet above sea level. A livable in-flight atmosphere is maintained by recirculating and dehumidifying the air continually.

Sky-Scanning Program

The cancelled November 1958 flight of the Stratolab was to be the second in a program of astronomical observations from balloons. The first was made to explore the possibilities of balloon lifted gondolas and determine the types of equipment that would be required. The flight was to include observations of the sun, also. After completing the study of Mars during the night, Dr. Strong was scheduled to remain at altitude until midmorning of the following day to collect data on the sun.

To include observations of both Mars and the sun on the same flight with the same equipment presented an interesting problem, viewing extremely divergent brightness intensities; those of Mars and the sun. The difference in brightness between Mars and the sun is in the order of 10^{10} (10,000 million times as intense).

The problem of 10^{10} attenuation in the operation of the equipment was solved by opaque filters flipped into place over the faces of both the primary telescope and the star tracker telescope with special equipment designed for the purpose by Librascope.

Stratobowl Selection

The selection of the Stratobowl in South

Dakota was dictated by several considerations. Wind is the natural foe of big balloons, especially at launching. At that time, with the big bag only partially inflated, the distance between the top of the balloon and the gondola is nearly 500 feet. Quiet air is essential for an orderly take-off.

In addition, for the purpose of the proposed flight, it was desirable that the ascension be made in a far northern latitude where Mars is available above the horizon for observation at night for the longest period of time.

Stereophonic Sound Broadcast in AM Band

A new radio broadcasting system that provides full stereophonic sound through a single receiver and dual speakers on the regular AM broadcast band was unveiled recently by the Radio Corporation of America (RCA).

The experimental system, described by Dr. James Hillier, vice-president–RCA Laboratories, as "perhaps the longest forward stride in the standard radio broadcast field in nearly 30 years," was demonstrated for the first time to an audience of broadcast station executives at RCA's David Sarnoff Research Center, Princeton, N. J.

"Until now," said Dr. Hillier, "there has been no stereo system that operates entirely in the AM range. This has left a gap in the pattern of stereophonic sound reproduction, since the bulk of commercial broadcasting and listening in this country, including all automobile radios, is in the AM band. With the closing of this gap, we can look forward to the ever more extensive use of stereophonic techniques in our radio programming and listening."

The operation of the RCA Laboratory stereo AM system was described in this way:

Two separate sound channels, picked up by two separate microphones or by a stereo disk or tape pickup at the studio, are transmitted on the regular broadcast frequency. A standard AM frequency is made up of a carrier wave and two symmetrical sidebands of slightly higher and lower frequencies to either side of the carrier. In the stereo system demonstrated to the broadcasters, each of the stereo channels is carried by one of these sidebands.

From each of the two microphones (left and right), the signal is amplified and then modulated, the carrier frequency being supplied by the transmitter's oscillator. In each case, this gives an upper and lower sideband, i.e., two left sidebands and two right sidebands. These are reduced to a single left and right sideband after passing through a band-pass filter and each goes to an adder before being amplified at radio frequency and going to the antenna.

In the stereophonic AM receiver, the two sidebands are separated and fed to two speakers, left and right, to reproduce the stereo effect picked up at the studio. Both left and right sidebands pass through an r-f amplifier, detector, and i-f amplifier. A sideband filter takes out the unwanted sideband in each case and the left and right sideband and its carrier pass through a pair of second detectors after which the separate sidebands are amplified at audio frequency and go to their respective speakers. In a present conventional AM receiver, there would be no separation of the two sidebands, so that the program would be heard in conventional fashioin without the stereo effect. The stereophonic receiver also can pick up nonstereo broadcasts and play them through either speaker or through both speakers, without any stereophonic effect.

It was demonstrated to the broadcasters with music from a stereophonic tape recording, broadcast over a laboratory-type AM stereo transmitter and picked up by the stereophonic receiver for playing through dual speakers of the type used in the RCA stereophonic phonograph system. The receiver also picked up a regular AM nonstereophonic broadcast from radio station WRCA in New York to demonstrate its adaptability to existing broadcast service.

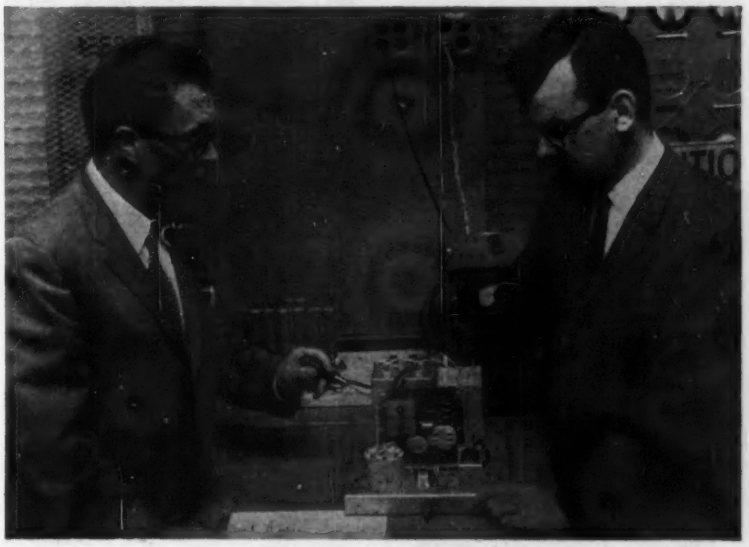
Dr. Hillier pointed out the following advantages of a practical stereophonic AM broadcast system, all of which are present in the new technique demonstrated.

1. Stereophonic music and other program material, either live or recorded, can be sent from a single transmitter operating within the present AM frequency of a broadcasting station.
2. Stereophonic reception is accomplished with a single receiver feeding into matched loudspeakers that can be brought into desired balance with a single control.
3. Since the system operates in the regular AM broadcast band, it can be used for automobile radios, for which FM systems are not practical.
4. The stereophonic system is adapted to present AM broadcast techniques, so that it could be introduced without causing obsolescence of present conventional receivers.

Discussing the role of stereophonic AM broadcasting in relation to present stereo techniques, Dr. Hillier said:

"So far, efforts to achieve in radio broadcasting the stereophonic sound now obtainable in phonograph systems have relied upon two techniques. One of these is an FM system operating entirely within the FM broadcast band. The other is a combination of FM and AM transmitted simultaneously in two different parts of the broadcast frequency spectrum—usually unmatched and difficult to tune to

High-Voltage Regulated D-C Supply Developed



MAGNETICALLY REGULATED high-voltage d-c power supply, developed at Bell Telephone Laboratories, New York, N.Y., is discussed by T. L. Tanner (left) and W. J. McDaniel. Supply is capable of providing 2,300 volts at 15 to 50 milliamperes with 0.25% regulation, features isolation of control and output-sensing circuits from high-voltage output, accomplished by placing control element—a self-saturating magnetic amplifier—on low-voltage input side of the regulated supply and by adding an auxiliary winding for output sensing. Conventional voltage doubler serves as high-voltage rectifier, with sufficient capacitance employed in filter to reduce maximum rms ripple to 0.50% at 50 milliamperes. Measured efficiency of circuit over restricted temperature range at full load is 82%.

the proper relationship for full stereo effect.

A stereo AM system, such as this one, can remove these limitations and place stereophonic sound for the first time on the same basis as standard AM broadcasting. For the listener, it means stereophonic sound in radio with only one receiver and one tuning adjustment, as simple in operation as the tuning of present AM sets. For the broadcaster, it means the ability to transmit live or recorded stereophonic programs with a single transmitter and within present operating AM frequencies."

Radar Detector Pinpoints Mortar-Fire Source

The front-line infantryman is not being forgotten in this age of rockets to the moon, earth satellites, and intercontinental missiles. A new mobile radar system designed to help protect the foot soldier from his most deadly enemy—mortar fire—was unveiled at the opening of the annual Association of the U. S. Army convention being held at the Sheraton Park Hotel, Washington, D. C.

Designated the *AN/MPQ-4A*, this new highly mobile, trailer-mounted radar system is capable of pinpointing the location of enemy mortars more than 6 miles away. It was developed jointly by the U. S. Army Signal Corps Research and Development Laboratory and the General Electric Company's (GE) Heavy Military Electronics Department in Syracuse, N. Y.

The new mortar locator detects the mortar shell in flight and electronically computes the exact location of the enemy mortar crew, permitting immediate, more accurate counterfire.

The importance of this new tactical radar system is dramatized by the fact that more than half of the Army's casualties of World War II were the result of enemy mortar fire. This proportion was even greater than during the Korean conflict.

As the antenna system scans the terrain where enemy mortars are located, it radiates two narrow beams of radio frequency energy. Energy reflected from a mortar shell passing through the two beams is picked up by the antenna and transmitted electronically to the radar display panel. The position of the mortar is computed from two intercept points and displayed in terms of grid map co-ordinates. This information is then relayed to artillery or mortar batteries for counterfire. The *AN/MPQ-4A* is designed for a maximum range of 10,000 meters (more than 6 miles).

The mortar locator operator sits in a seat facing the computer panel. When a mortar shell passes through the two radar beams, two target echoes are illuminated on the radar indicator screen. These are marked by the operator, who then positions vertical and horizontal electronic strobe lines over the marks. Manually, through dials on the panel, he puts the intercept points in the computer which solves the weapon location problem.

All equipment for the *AN/MPQ-4A* radar is mounted on two 2-wheel trailers. One trailer carries the primary radar equipment, while the other carries the primary power supply (gasoline engine–generator set) and auxiliary cable and spare parts equipment. The *AN/MPQ-4A* can also be used to locate points of impact for the direction of counterfire. Locating an impact point is done in the same way as locating a mortar position.

The *AN/MPQ-4A* mortar locator is currently being produced in quantity by General Electric (GE) for the U. S. Army Signal Corps. GE's Heavy Military Electronics Department in Syracuse, N. Y., is producing electronic components, and assembling and testing completed systems. The antenna assembly, which includes the Foster scanner, pedestal, reflector, and support structure, is being produced by GE's Ordnance Department in Pittsfield, Mass.

To achieve quantity production of the high-precision Foster scanner, yet maintain interchangeability of parts, GE has developed new and unusual skills, techniques, and machines. Examples are the taper boring of the 5-foot scanner shell to a tolerance of 0.001 inch over its entire length and new developments in air gauging to check wavepath gaps in the final assembly. Utilization of new methods includes electroerosion cutting of line slots.

Aluminum Widely Used in Constructing Power Plant

The new Warwick steam electric power station, now under construction in Warrick County, Ind., near Evansville, for a subsidiary of Aluminum Company of America (Alcoa), is a 3-dimensional catalog of tested and proved applications of aluminum in power-station design. It also includes aluminum in several design features new to power stations, but well established in other fields.

The 375,000-kw power plant is being built adjacent to the site of the aluminum smelter at the company's new Warrick works. Comprising three units, each with a nameplate rating of 125,000 kw, it will supply the power to produce 150,000 tons of primary aluminum annually, the capacity of the new smelter.

Aluminum uses in the new station will total approximately two million pounds. This represents 5.23 pounds of aluminum used per kw of installed capacity.

Electrical equipment comprises a virtually all-aluminum installation. Conductor, switchyard structure, switchgear, conduit, panels, cable trays, and lighting fixtures are major applications. Almost 40% of the aluminum used in the station is employed in the boilers, turbines, condensers, and feedwater heaters, and their auxiliary and structural components. Among these applications is the aluminum boiler "lagging," the outer skin protecting the thermal insulation covering the steel inner casing of the boilers. The generator-reactors and the current-limiting air-core reactors employ aluminum windings. All conduit above ground, and all junction boxes, are aluminum. Control and low-voltage power cables are supported on expanded aluminum cable trays. Lighting panels, lighting fixtures, and Hexcel ceilings are of aluminum, as are enclosures of 4,160- and 480-volt switchgear and of motor control centers.

In the three condensers, 165 miles of 1-inch Alclad (inside) *3003-H14* tubes are used. Substantial quantities of aluminum tubes are used in the #1 and #2 low-pressure feedwater heaters of all three units.

Considerable aluminum is used for components of the turbine-generators: lubrication oil coolers, gland exhausters, and hydrogen coolers.

Turbine maintenance will be performed with the aid of an all-aluminum canopy. A quonset-type structure, the canopy consists of six sections that may be moved independently on rails running the length of the turbine deck. Some 84,000 square feet of grating are installed in the steam generator auxiliary areas and in the station proper.

Substantial use of aluminum is made in such diverse additional all-aluminum applications as condensate and oil tanks, control panels and control tubing, reflective insulation and insulation lagging, conveyor and trench covers, capillary air washer, stack ladders, and stack lighting platforms.

Architectural aluminum is specified for use throughout the plant. Insulated ribbed industrial siding panels will be used on all heated buildings. Regular ribbed industrial siding will be used on all unheated structures. The gate house and administration building will be sheathed in color-anodized ribbed siding. Among the many other long-established architectural applications of aluminum employed are the ventilating system, air-conditioning ducts, windows, doors, thresholds and sills, and hardware.

The power station will be operated for

AN/MPQ-4A mortar locator radar developed for the U. S. Army Signal Corps by GE is shown being tested. Mobile trailer-mounted pulsed-magnetron radar system detects mortar shell in flight and electronically computes the location of the enemy mortar.

the Alcoa subsidiary, Alcoa Generating Corporation, by Southern Indiana Gas and Electric Company. The plant will be connected with Southern Indiana's system by two 138-kv tie lines. Present schedules call for essential completion of the plant's three units by the middle of 1959. Unit number one is now completed. The power plant will be available to supply power when the initial smelting works potline is activated.

Consultants for the power development are Ebasco Services, Inc., who are serving as designer, purchasing representatives, and construction supervisors for the entire project.

Automatic Electronic Focusing System Developed

An automatic electronic focusing system demonstrated recently is declared to be ready for a wide variety of applications in scientific, optical, industrial, military, and other related uses.

Known as OAR (Optical Automatic Ranging), the system has been demonstrated in laboratory models by Comapco, Inc., Encino, Calif.

Basically, OAR makes use of a continuously and rapidly oscillating photoelectric cell, or "sensor," to measure light intensities along the optical axis of a lens, within the focal region. When the midpoint of the sensor's back-and-forth motion coincides with the focal plane of the lens, the sensor emits an electric signal the frequency of which is twice its rate of mechanical oscillation. Any shifting of the focal plane away from that midpoint, however, decreases the signal frequency and also shows a shift of phase indicative of the direction of the shift.

These tell-tale variations in sensor signal are converted into commands to a servomechanism system, which shifts the lens to restore the sharpest focus to the midpoint again. The servo adjustments can also make other adjustments, depending on the particular use to which OAR is being put.

Thus, according to Mell Greene, director for Comapco's continuing research and co-inventor of OAR, the new system can keep a lens or mirror system accurately focused on whatever object is in the center of the field of view, no matter how often the distance of such object is altered. Further, OAR can also work as an automatic optical monitor in mass production where size of product is a critical factor.

According to Mr. Greene, and his co-inventor, H. A. Engle, the relatively simple and rugged OAR system is suited also to automatic ranging, tracking, warning, and safety devices of many kinds. OAR, they point out, operates without complicated optical elements in the path of the light rays, and without complicated electronic switching or "gating" devices in the electrical circuitry. Besides the oscillating sensor and its simple controls, OAR requires only a signal amplifier, a servo amplifier, and a servo motor apparatus. With somewhat different lens and sensor elements, OAR could operate on heat (infrared) radiations, or actinic (ultraviolet) radiation. Used with infrared, OAR is suited for many applications in measurement and control of extremely high temperatures, under conditions which would make most difficult the use of existing thermometrical or thermostatic devices.

A threefold sensor element virtually eliminates all troublesome "tilt effect" which is caused when a bright object appears in the line of sight, slightly off the center of the lens.

By modifying the electrical connection of the threefold sensor element, OAR was made especially responsive to off-center objects, and thus able to function as a tracking device which "notices," then turns toward, and gets the range of bright objects slightly off the center of the lens system.

Sole source of power for the OAR prototype is standard 100-115 volt 60-cycle alternating current, such as is supplied in standard households throughout the land. This actuates not only the vibratory motion of the sensor element, but also the two amplifiers and servo-motor systems.

The basic operating pattern of OAR remains the same, whether it is operated through the radiant energy of light or of heat vibrations. This pattern has five essentials:

(1) The focusing lens or mirror system.

(2) The uniformly and continuously oscillating sensor element, moving along the axis of the lens or mirror to explore and report energy distribution.

(3) The two-times-oscillatory rate of signal fluctuations from the sensor when the midpoint of its oscillatory travels coincides with the plane of focus.

(4) The decrease in rate and the disphasing of the sensor's signals as the focal plane is separated farther from the midpoint of its motion (a dis-phasing that is opposite when the separation is toward the lens or mirror system, rather than when it is in the opposite direction).

(5) The resulting immediate and readily interpreted passing on of these signals to the servomechanism, which at once makes whatever mechanical movements have been predetermined to return the plane of focus to the midpoint of sensor motion.

Inquiries on applications and possibilities of the OAR systems are invited at this time by Comapco, Inc. Inquiries may be addressed to C. A. Price, Jr., Secretary of Comapco, Inc., at Suite 207, 17071 Ventura Boulevard, Encino, Calif. Comapco's telephone number is STate 9-0256.

Gaseous Fuel Cell Provides Electric Power

A recent experimental development of a gaseous fuel cell was successful in lighting two 15-watt electric light bulbs at the Allis-Chalmers (A-C) Research Division.

As a device that provides electric power, the fuel cell resembles the electric storage battery. It consists of electrodes and an electrolyte. But instead of storing energy, the fuel cell instantaneously converts chemical energy obtained from an external source to electric energy.

One of the oldest devices still in the world-wide research stage (fuel cell history goes back over 100 years), its value lies in the fact that it converts chemical energy directly into electrical energy. When the total chemical energy of a gaseous fuel is converted directly into electrical energy, high efficiency may be expected.

Present efficiencies of the best heat cycle engines (diesels) are about 40%. The fuel cell has a possible efficiency of 90%. It escapes the heat cycle energy losses because it does not convert chemical energy to heat energy.

In this A-C fuel cell, hydrogen gas is adsorbed onto the catalyst at the anode. Activated there, it reacts with an ion in the electrolyte, releasing an electron to the external circuit. At the cathode, oxygen gas is simultaneously adsorbed. Activated, it reacts with the electron from the external circuit and with the electrolyte to re-form the ion that disappeared at the anode.

The over-all reaction is the disappearance of hydrogen and oxygen to yield water and the flow of electrons through the external wiring circuit at the voltage characteristic of the chemical reaction.

The electrons that light the lamps are forced to do so before the chemical reaction is completed. Consequently, all the electrical energy delivered by the cell is converted chemical energy.

Industrial possibilities for a commercial fuel cell are manifold. Direct current for adjustable speed motors along with extra available power for peak loads are two considerations. As a source of stored energy, the compact fuel cell could be readily applied to defense project units, marine, municipal, hospital services, as well as used as a power source in remote areas.

By using generating facilities during off-peak periods to produce hydrogen and

ILLUMINATING itself as well as an Allis-Chalmers (A-C) research scientist is a gaseous fuel cell. It is a recent experimental development of the A-C Research Division. It is said to be the first of its type to light the two 15-watt bulbs seen in the photograph.

oxygen, power companies could store and transfer the gases for use anywhere a fuel cell arrangement was established.

The demonstrated 24-volt cell is one in a series of experimental laboratory models which are being constructed to obtain experimental results that will be incorporated into fuel cell designs for tests on a greater scale.

The A-C developed cell normally operates at room temperature and makes use of a catalytic electrode surface. Other fuel cell research at the Research Division has included operating studies at elevated temperatures.

Diesel-Electric Units for Reserve Power Plants

After extensive studies of the central station industry in co-operation with the utilities, and having reached a saturation in the manufacture of diesel-electric locomotives, General Motors Corporation (GM) has seriously decided to enter the power-generating field as a supplier. This was announced by N. C. Dezendorf, vice-president of the corporation and general manager of its Electro-Motive Division, La Grange, Ill.

As well known, the utility load doubles itself approximately every 10 years. Also, base-load steam plants 12 to 15 years hence become peaking-load plants operating at a low plant-load factor. If portable diesel-electric generating units strategically located on systems are used to carry the peak loads, capital investments in new steam plants may be deferred thus resulting in considerable savings.

To meet the situation, GM has made available a new 6,000-kw diesel-electric unit for peaking and reserve power, known as the *MU60*. The plant is contained in four boxes, three of which house the generating units and one the controls, and is automatic with self-protective devices. It can come on the line fully synchronized at full load in 90 seconds. The plant is quiet, operating at a noise level of 80 db measured 100 feet away at full load. This noise level compares favorably with that measured at busy metropolitan street intersections. The 6,000-kw machine will be marketed at $85 per kilowatt f.o.b., and from the studies it has been estimated that the plant can be sold installed most anywhere in the United States on reasonably level terrain for less than $100 per kilowatt. Inasmuch as all components are made by the manufacturer, a service contract will be offered. When the *MU60* goes into production this spring, it will be powered by a turbo-charged engine instead of the Root blower which will reduce sound level still further.

From studies made of the economics of the units and working with utilities and utility consulting engineering firms, each study on a conservative basis has indicated substantial potential reductions in required investment if the proper amount of specialized automatic peaking power were applied at the right price at the right place. A study of a 100-mw utility, which is quite small, showed potential savings of $1 million a year for 10 years. A 300-mw utility showed potential savings of $1½ million for 5 years. A 500-mw utility showed potential savings of $3½ million for 20 years, and a 2,000-mw utility showed potential savings in steam generation alone, not including transmission savings, of $5½ million a year for 20 years.

Einstein's Theory Is Experiment Confirmed

A unique, phenomenally high-precision experiment has given strong further confirmation of Einstein's Special Theory of Relativity, it was announced jointly by the International Business Machines Corporation's (IBM) Watson Research Laboratory and the Physics Department of Columbia University, New York, N. Y.

In perhaps the most precise experiment in the history of man, IBM and Columbia scientists have systematically measured the variation in frequency of radio waves radiating from a beam of "excited" ammonia molecules, over a period of 1 day. The experiment shows exactly what changes in wave frequency may occur when the stream of molecules travels in the same direction as the earth in its orbit and when it travels in the opposite direction.

Basic to Einstein's Special Theory of Relativity is the statement that the velocity of light (or, of radio waves) is independent of its frame of reference or of the motion of the light source itself. According to his theory, there should be no change in light velocity, or in radio-wave frequency, when the molecular beam "source" travels with the earth's orbital velocity or against it. Previous experiments, starting with the classic Michelson–Morley experiment of 1887, generally confirm Einstein's theory, but have an accuracy which is considerably limited by the experimental methods used.

The results can be expressed in terms of the earth's velocity with respect to a fictitious ether which before Einstein's theory was thought to pervade the universe. The present experiment using a MASER (microwave amplification by stimulated emission of radiation) shows that any velocity with respect to such an ether is 50 times less than the amount detectable by previous experiments.

The MASER is a tubular cavity through which flows a beam of ammonia molecules radiating waves at their natural frequency. It was first developed by Prof. C. H. Townes, J. P. Gordon, and H. J. Zeiger of Columbia University in 1954 and shows promise of wide use in science and industry.

In this experiment, J. P. Cedarholm, G. F. Bland, and B. L. Havens of the IBM Watson Research Laboratory, and Prof. Townes use the MASER as a sort of atomic clock that measures molecular wave frequencies to an accuracy of one part in one million-millionths (one followed by 12 zeros). This unprecedented accuracy in an actual experiment is the result of the MASER's ability to count time intervals with a precision enormously greater than that of previous experimental methods using physical distances for measuring light velocity.

The Watson Scientific Computing Laboratory at Columbia is operated by IBM in collaboration with Columbia.

Computing facilities of the laboratory, the only numerical calculation center of its kind in the world, are available to scientists engaged in basic research. Within its comparatively short history, the laboratory has helped solve problems of more than a hundred research projects conducted by scientists on five continents, in such fields as anthropology, astronomy, chemistry, economics, engineering, physics, and psychology.

PROTOTYPE PLANT built in four boxes, three of which are the generator units and one the unattended control station. Installed at the GM Electro-Motive Division plant at La Grange adjacent to the distribution point from the Commonwealth Edison system, the installation has been visited by a number of utility groups.

Better Access to Scientific Information

Acting upon the recommendations of his Science Advisory Committee, President Eisenhower directed that the National Science Foundation (NSF) take the leader-

ship in bringing about effective co-ordination of the various scientific information activities within the Federal Government. The President asked that all Federal agencies whose programs involve scientific information co-operate with and assist the NSF in improving the Government's own efforts in this area.

The Committee urged that fullest use be made of existing information services, both public and private, and that the Foundation's Science Information Service supplement rather than supplant present efforts.

Dr. J. R. Killian, Jr., Special Assistant to the President for Science and Technology and Chairman of the Science Advisory Committee, commented on the growing dimensions of world scientific publication to the extent that it has become a problem requiring action at the national level.

"Science and engineering are largely built on the published record of earlier work done throughout the world," Dr. Killian stated. "There are, for example, 55,000 journals appearing annually, containing about 1.2 million articles of significance for some branch of research and engineering in the physical and life sciences. More than 60,000 different books are published annually in these fields, while approximately 100,000 research reports remain outside the normal channels of publication and cataloging. Within this vast body of world-wide scientific information, published and unpublished, lie the technical data that scientists need in order to do their work. The situation is further complicated by the fact that a large and important proportion of the world's scientific literature appears in languages unknown to the majority of American scientists, such as Russian and Japanese."

In its recommendations, the President's Science Advisory Committee outlined a program calling for the review, co-ordination, and stimulation, on a nation-wide basis, of activities in the areas of primary and secondary publications, scientific data centers, unpublished research information, storage and retrieval, and translation by mechanical means.

No new agency will be required to carry out the recommended program. Under its enabling act, the National Science Foundation has devoted special attention to the scientific information needs of scientists and has developed a series of programs designed to help meet those needs. At least 10 other Federal agencies are engaged in abstracting and indexing, translating, preparation of technical reports, and research related to information needs. These agencies are asked to co-operate in providing or arranging for acquisition and reference programs, clearing-house functions, and evaluation studies of existing programs. Research on new and improved methods of information-handling will be emphasized and the Department of State will take the lead in encouraging co-operation among the United States, foreign, and international scientific information organizations.

In submitting its findings the subcommittee paid special tribute to the work of individual scientists and engineers in selecting, interpreting, and abstracting scientific and technical information. It noted the fact that the services rendered by many of the scientific societies and professional institutions to the scientific community in the information field are world famous for their quality. It expressed the hope that such private groups would continue to co-operate with and assist the Federal Government in the achievement of long-range solutions to scientific information problems.

Water Tunnel Aids Fluid Motion Research

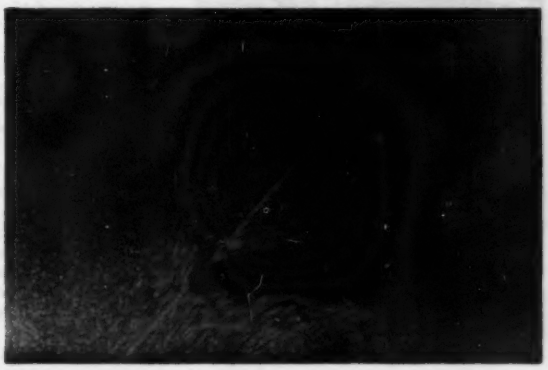
A unique "water tunnel," which permits three-dimensional studies of fluid motion around complex structures, is helping Westinghouse Electric Corporation, Pittsburgh, Pa., perfect designs for steam turbines, large ventilating fans, and other rotating equipment.

Essentially, the water tunnel serves the same purpose as a wind tunnel, although it is smaller and uses a liquid medium rather than air. The tunnel allows engineers to study and photograph fluid flow around a structural model or machine component. Flow patterns around a simple structure, such as a sphere, can be calculated comparatively easily. However, mathematical analysis is too cumbersome for intricate structures, so the water tunnel was developed to provide needed development information. The new water tunnel makes possible flow studies of both stationary and rotating models, and for the first time permits the viewing of fluid travel past all the surfaces of a complex rotating structure under actual operating conditions.

For research purposes, a water tunnel offers several advantages over a wind tunnel. Because water is more dense than air, it will produce the same flow patterns when moving only about one thirtieth as fast as air. For example, a turbine blade rotated in water at 200 rpm will simulate the same conditions as when rotated in air at 6,000 rpm.

Highly turbulent flow around closely spaced objects cannot be seen satisfactorily in a wind tunnel but is readily visible in a water tunnel. The water tunnel is actually a vertical pipe, about 2 feet in diameter and 20 feet high. One section of the pipe is made of clear plastic, inside which the model being studied is mounted. A 7½-hp electric motor rotates the model. The propeller pump used to force water through the pipe is powered by a 30-hp electric motor. Flowing through the pipe are 13 tons of water, moving at a rate of 8,000 gallons a minute.

A stroboscopic flash unit is used to photograph the flow. Tiny air bubbles, oil droplets, or small particles of plastic are injected into the water stream to make the flow pattern visible. The temperature of the entire 13 tons of water in the tunnel is adjustable from room temperature up to 150 F.



FLUID FLOW past single turbine blade is made visible for scientific study in Westinghouse Research Labs water tunnel. In picture, tiny air bubbles reflect light of powerful high-speed electronic flash to make flow turbulence visible.

Pyroceram—from Radome to Range

It is a long step from the nose cone of a missile to the kitchen range, but that is what the Corning Glass Works has done with its superceramic, Pyroceram. When the material was announced (*Electrical Engineering*, August 1957, p. 755), its only known use was for the nose cones of guided missiles because of its heat-resistant qualities.

Some 400 Pyroceram compositions were developed and tested at the Corning research laboratories. The latest use is a line of saucepans and skillets impervious to sudden changes in temperature from the heat of the oven or stove to the freezing compartment of the refrigerator and vice versa.

Teleprinter Speeds Korean Mass Communications

A noted Korean eye surgeon will probably go down in history as the father of mass communications in his beleaguered country.

In 1944, Dr. Byung Woo Kong—foreseeing the liberation of his country from Japanese rule—began to translate medical textbooks into the Korean language. It was a laborious and time-consuming task. The translations had to be hand-written, for no one had evolved a compact, simple-to-manufacture Korean typewriter.

As he contemplated the slowly rising pile of manuscripts, and the hundreds of yet untranslated books before him, he

knew that he had to have a typewriter. Looking beyond his own needs and those of the medical profession, he saw that his people required the means for low-cost mass communications if the rich cultural Korean heritage was to survive. He dreamed of typewriters, teletypewriters, and typesetters, and then set to work to make his dreams come true.

His first problem was to adapt the standard typewriter keyboard, easily mass produced cheaply, to the Han-gul language—a most difficult task.

The Korean alphabet is phonetic, consisting of 14 consonants and 10 vowels. In addition, there are 15 characters called "sub-consonants." For keyboard purposes basic characters are designated as consonants, double consonants, sub-consonants, vertical and horizontal vowels, any three of which can appear in two spaces to produce a syllable or word.

Consonants appear above the center of the type line, while sub-consonants are typed directly below. The horizontal vowels fall between. Several characters are identical, except for position on the line, being placed above, below, or between other letters. Dr. Kong solved the problem of the sub-consonants by placing them on "dead" keys which do not advance the carriage.

The pilot model of the Han-gul typewriter was completed in 1948 and exhibited at the U. S. Information Service building in Seoul. However, the Korean War intervened, and not until 1953 was Dr. Kong able to work out a contractual manufacturing agreement with Smith-Corona. Typewriters are now available in standard, electric, and portable models, and are distributed through the Kong Korean Typewriter Company.

For his own use—and for future mass production—Dr. Kong has designed a unique combination Korean-English portable typewriter. Also built by Smith-Corona, each type pallet contains an English and a Korean character. Depressing the shift key produces Korean. When one of the fifteen "sub-consonants" on dead keys is struck, the carriage does not advance. When the same key is struck to type an English character, the carriage advances normally.

DR. BYUNG WOO KONG, noted Korean eye surgeon (left) helps technician check type alignment of Korean language teleprinter he designed in co-operation with the Kleinschmidt Division of Smith-Corona Marchant.

Dr. Kong next turned his attention to the problem of high-speed printed communications. Using the Korean typewriter keyboard, he set to work adapting it to the Kleinschmidt teleprinters used by the U.S. Army Signal Corps.

Working closely with the engineers of the Kleinschmidt Division of Smith-Corona Marchant, Dr. Kong made the drawings for the type pallets himself. A new code system adaptable to the Korean characters had to be devised, and many changes made in the mechanisms of the teleprinter so that, for instance, the carriage would not advance when the eight sub-consonant keys are struck.

Finally, in May 1958, the first teleprinted copy ever made in the Korean language was produced on the experimental Korean version of a Model *152* Page Printer. At the time, Dr. Kong said that it would not be long before there was a printed communications network throughout his country using the native Han-gul language. Indicative of his forecast, an initial order has been placed for 12 machines by the Korean National Police for its nation-wide communications network. The order was completed in November, and additional orders from other agencies in Korea are expected.

Not content with having developed Korean language typewriters and high-speed teleprinters for his people, Dr. Kong is now hard at work on a typesetting machine for the mass production of low-cost newspapers and books.

Meanwhile, Dr. Kong keeps up his practice as eye surgeon and specialist at his clinic in Seoul, which is the largest privately operated eye hospital in Korea. In addition, he spends one day a week at Sung Ke Won Leprosarium in Bupyung treating leprous eye diseases.

In co-operation with Seoul National School for the Blind he sponsors the education of the sightless in the use of the Korean typewriter. He is also a devoted husband and father of nine children, three of whom are attending colleges in this country.

Though Dr. Kong is probably best known and loved today for his medical and charitable work among the blind and diseased, his contribution to mass communications—which grew out of his medical work—will earn him a lasting place in the history of his embattled country.

Standardization—A Must for the Space Age

The United States will become a second rate nation unless its technical men and industrial management raise their standards to provide almost 100% reliability for parts used in today's complex tools and apparatus. This was emphasized at the 7th Annual Meeting of the Standards Engineers Society (SES) held in Philadelphia, Pa., recently. Theme of the meeting was "Standardization—A Must for the Space Age." Standards engineers from companies, associations and societies, and Government organizations from all parts of the United States and from Canada attended the meeting. SES now includes members in Great Britain, India, Australia, The Netherlands, and Sweden.

Speaking at a luncheon, H. T. Hallowell, Jr., president, Standard Pressed Steel Company, and president of the American Standards Association, called on standards men and on industrial management to upgrade standards. Failure of individual parts in today's complex apparatus is costing the country $20 billion a year, he said.

To meet today's requirements for production of electronic equipment, complex household apparatus, automobiles, machine tools, as well as missiles, rockets, and space vehicles, manufacturing companies must specify exactly what they need to produce reliable equipment that will operate without breakdown and must insist that their suppliers provide the needed reliability. In development of standards, the thinking of 1890 must be discarded and standards must be up-graded, he said. The problems of materials and their reaction to conditions of outer space and nuclear radiation were emphasized. The extremely long life that will be expected of materials in the space age is one of the unique problems that will have to be faced, G. W. Monk told the standards engineers. Mr. Monk is with the American Machine & Foundry Company, Alexandria, Va. In flights to planets or in continuous orbital paths, the structure and components must be reliable for periods of many months and years. He called attention to the fact that under long-service conditions creep will become significant; structures will not have to support their own weight as they do on the earth's surface; and these structures may be extremely flimsy since there will be no weight and no wind. On the other hand, there will be no air to help damp out vibrations. Also new will be the fact that materials may be exposed to intense nuclear radiation fields, and that larger units will have nuclear plants either for auxiliary power sources or for direct propulsion.

Complex equipment, posing complex maintenance problems, is calling for capable individuals which the country now lacks, said R. W. White, chief of the Standardization and Engineering Service Section, Office of the Chief of Ordnance, Department of the Army. Mr. White spoke during a symposium on problems in standardization created by the expansion of man's activity into space. Although mounting costs of missiles and space vehicles make it imperative that standardization be exploited to the full for cost reduction, such equipment is produced only in limited runs and standardization must be directed to components and parts, he pointed out. Rapidly changing technology leading to early obsolescence works against standardization, but modularization of electronic equipment is one example of successful standardization, providing a logical and compact arrangement of components in a packaged unit to save space and make possible automatic production techniques.

A great deal of work has been accom-

plished in developing a unified drawing standard for use in the United States, Britain, and Canada, G. M. Noble, Dominion Engineering Works, Ltd., Montreal, Que., Canada, declared. However, some differences of practice still remain to be reconciled, none of these insuperable obstacles to a completely unified document. He urged that more energetic efforts be made to resolve these differences so that the ABC countries will present a united front in the work of the International Organization for Standardization.

Standards engineering calls for professional preparation—education, training, or both, Dr. John Gaillard, management consultant, told the Society's members. He pointed to three distinct phases. First, he said, many top executives still have to be educated in the value of standards engineering as a function of industrial management, and in the necessity of lending their full support to the standards engineer's work.

Second, the standards engineer should be educated in the basic philosophy of standardization, of which standards engineering is an application to industrial actvities. He should also be educated and trained in setting up the necessary administrative machinery and procedure in an industrial enterprise and in the art of writing specifications.

Third, for maximum results, the rank and file should be educated in the essential purpose of standards engineering, so as to promote the spirit of co-operation in the program.

In the course of time, standards engineering may be expected to be taught as a regular subject in college courses, Dr. Gaillard declared. For the present, however, he said, industry must rely on private sources, seminars, and consultation.

The Standards Engineers Society is undertaking a research and education program and has organized a committee for this purpose, M. S. Gokhale, chairman of the committee, reported.

The program, as approved by the SES Board of Directors, includes the following:

1. Preparation of a handbook on various standardization subjects, for daily guidance and other reference purposes by the standards engineers, as follows:
   - (a) Various chapters of this handbook will be written by the authorities on each subject.
   - (b) Editorial responsibility will be with the SES Research and Education Committee.
   - (c) Production and printing will be contracted with a reliable publisher of technical handbooks.
2. Establishment of a roster of available speakers and lecturers on standardization topics to senior college students in technical schools.
3. Creation of a scholarship for a course in standardization through an accredited fellowship or a foundation.

Wear Your ◆ AIEE Badge

New Atom Tool Previewed as Oldest Is Decommissioned

A new atomic research "tool"—the Westinghouse Testing Reactor (WTR)—was previewed recently at the same time that one of the oldest industrial atom smashers was decommissioned. The decommissioning ceremony was held at Westinghouse Electric Corporation's atomic power department headquarters in Forest Hills, near Pittsburgh, Pa. With a roar, compressed air was released from the giant smasher's pear-shaped pressure tank that housed the Van de Graaff generator used for 20 years in scientific studies aimed at unlocking some of the secrets of nuclear fission.

The department's technical director, Dr. W. E. Shoupp, veteran Westinghouse atomic scientist under whose supervision the 90-ton atom smasher was built and operated since 1938, turned the valve that released the air pressure and signified decommissioning of the device. Dr. Shoupp's work with the atom smasher, in which subatomic particles were shot down a 40-foot vacuum tube at velocities ranging from 30 million to 100 million miles per hour, led to the discovery of photofission —the process of splitting the uranium atom into two fragments by impact of gamma rays.

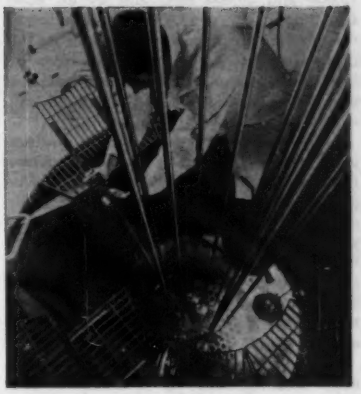
At the 850-acre WTR site near Waltz Mill, Pa., E. T. Morris, manager, said that the company's newest atomic research and development tool will go into operation in May 1959. He described the installation as "an additional research and testing tool to help solve the many fuel and material problems which must be solved if economic nuclear power is to become a reality."

The primary purpose of the WTR will be to subject materials and nuclear fuels to radiation conditions similar to those encountered in an operating power reactor. It also may be used for the limited production of radioisotopes for industrial and medical use.

A large vapor container—an 85-foot-high cylinder measuring 70 feet in diameter and made of ⅜-inch steel plate—will house the nuclear reactor itself. When the reactor is in operation the plant's air handling system will change the air in the vapor container once every four minutes. Air pressure in the container will be slightly less than the outside atmosphere so that any leakage will be inward.

The area directly below the reactor contains a canal 100 feet long with a minimum width of 7 feet. Filled with 18 feet of water, the canal leads to three "hot" laboratory caves located in the service building. Thus, transfer of materials will be done entirely under water. The hot labs will contain complete facilities for the remote handling and examination of irradiated materials and equipment. Viewing into the hot cells will be through special windows 33 inches thick. Walls of high density concrete, 3 feet thick, provide shielding of the cells.

Although the initial operation of the reactor will be at a power level of 20,000 kw of heat, the plant has been constructed to permit operation at any level up to 60,000 kw with some additional equipment and minor building changes.



LOOKING DOWN into water-filled steel tank, photograph shows top portion of nuclear core for Westinghouse Testing Reactor now under construction. Shown rising above the top of the core are control rod extensions which connect control rods to drive mechanisms located above. Fuel for reactor is enriched uranium in the form of about 60 fuel elements arranged in the core-supporting structure.

Severe Storms Identified by Long-Range Radar "Warning"

Potentially dangerous thunderstorms "telegraph their punches" so that long-range weather radar observers can separate mild from severe storms, according to two Air Force Cambridge Research Center (AFCRC) scientists. This report was given at the 7th Weather Radar Conference at Miami Beach, Fla., by A. C. Chmela and R. J. Donaldson, Jr., members of AFCRC's Weather Radar Branch, Geophysics Research Directorate, located atop Great Blue Hill in Milton, Mass. AFCRC is one of 10 Air Research and Development Command (ARDC) centers in the United States.

Using somewhat different approaches to the problem of identifying severe thunderstorms by radar, they found that dangerous types of storms have much more intense radar echoes in their upper portions than do ordinary thunderstorms.

Most thunderstorms are not severe. In only one third of the southern New England storms studied by the AFCRC Weather Radar Branch in 1957, hail reached the ground, and only a small minority of thunderstorms were capable of causing serious damage by releasing tornadoes or other severe windstorms.

Mr. Chmela traced development of a squall line that passed through New England on June 19, 1957, causing five tornadoes, widespread wind damage and hailstones up to the size of golfballs. Hundreds of photographs of the radar echo were recorded, providing a concrete record of storm intensity changes in space and time.

The storms that produced tornadoes and other severe events were characterized by a pronounced maximum intensity of the radar echo at altitudes between

16,000 and 26,000 feet, and by an echo top height above 44,000 feet. Maximum radar echo in severe storms was 10 to 100 times stronger than the greatest recorded in three fourths of ordinary thunderstorms in which no hail reached the ground and no severe winds were reported.

Mr. Donaldson reported similar findings in a survey of vertical profiles of echo intensity in 63 New England thunderstorms. He also noted the lack of significant difference near the ground, but pointed out that at 20,000 feet the typical hailstorm echo is nearly 10 times as intense as the typical thunderstorm without hail. Two tornadoes included in this study had echoes 33 and 230 times as intense as the typical rainstorm echo.

At 35,000 feet, the differences are even more striking, said Mr. Donaldson. The typical hailstorm's radar echo is more than 60 times as strong as the typical rain thunderstorm at this altitude. Two tornado storms observed had echoes 600 and 1,000 times as intense as the "normal" thunderstorm.

The shape of the vertical profiles also characterizes the type of storm. The most intense echo of the typical rain thunderstorm is near the ground, and the intensity falls off with height. A hailstorm registers its peak echo at 17,000 feet, and the intensity of echoes from tornado storms increases markedly up to a maximum around 21,000 feet.

A third radar indication that a severe storm is occurring is by the detection of lightning flashes, Dr. David Atlas, chief of the Weather Radar Branch, told the Miami meeting. Three types of thunderstorm echoes appear on radars normally used for detection and height-finding of aircraft, he said. The main echo comes from rain, hail, or ice crystals. From time to time, on a single sweep of the radar beam, an echo appears that is believed to indicate reflection of radar waves from ionized air left in the wake of a lightning discharge between clouds or vertically upward from the top of the storm.

Dr. Atlas' report dealt mainly with a third type of signal, a dotted line extending from the radar position to the storm. Known as a sferic, this signal is the direct reception of electrical energy transmitted by a lightning discharge. In this instance, radar acts only as a receiver and lightning acts as a transmitter.

One of the most interesting lightning features which has been disclosed by these observations is that many, if not most, sferics originate at the very top of a thunderstorm, and not in the lower levels as has generally been thought. Indeed, Dr. Atlas suggested that the sferics are associated with the initiation of a discharge and that these discharges progress upwards, causing the ionization which is responsible for the subsequent lightning echoes.

Dr. Atlas showed that when the number of sferics detected per hour is high, severe weather is generally experienced at the corresponding time and location within the storm. However, he noted, lesser sferic rates do not necessarily indicate the absence of severe weather and tornadoes. Dr. Atlas also noted that a number of existing weather radars are sufficiently sensitive to be used as sferics detectors.

Latest Information Available from the AEC

The U. S. Atomic Energy Commission (AEC), Washington 25, D. C., has released certain information of interest to the general public. These items are noted in the following listing.

Number	*Title*
A-264	AEC–Air Force Invite Proposals for Factory-Assembled Nuclear Power Plant
A-269	AEC Invites Industry To Participate in Fuel Cycle Development Program
A-278	AEC Announcement
A-288	AEC Proposes Amendment Giving License Exemption to Users of Products Containing Low Concentrations of Radioisotopes
A-290	AEC Sells Highly Enriched Uranium to Australia for Research Purposes
A-298	AEC Requires Additional Safeguards in Handling of Sizable Amounts of Special Nuclear Material
A-299	AEC Amendment Allows for Additional Licensed Uses of Special Nuclear Material
A-301	U.S.–Euratom Agreement for Cooperation Signed
A-304	Proposed AEC Licensing Amendment Would Require Quarterly Status Reports on Reactor Construction
A-305	AEC Modifies Third Invitation under Power Demonstration Reactor Program
A-311	AEC Receives Proposal for Gas-Cooled Graphite-Moderated Nuclear Power Plant
A-312	AEC Notice of Modification of the 1962-1966 Domestic Uranium Concentrate Procurement Program
A-314	Proposed AEC Action Would Enlarge Scope of Public Records Relating to Licensing

LETTERS TO THE EDITOR

INSTITUTE members and subscribers are invited to contribute to these columns expressions of opinion dealing with published articles, technical papers, or other subjects of general professional interest. While endeavoring to publish as many letters as possible, Electrical Engineering reserves the right to publish them in whole or in part or to reject them entirely. Statements in letters are expressly understood to be made by the writers. Publication here in no wise constitutes endorsement or recognition by the AIEE. All letters submitted for publication should be typewritten, double-spaced, not carbon copies. Any illustrations should be submitted in duplicate, one copy an inked drawing without lettering, the other lettered. Captions should be supplied for all illustrations.

Atomic Nucleus Letter Corrected

To the Editor:

In the December 1958 issue of *Electrical Engineering*, Letters to the Editor section you published my letter entitled "Atomic Nucleus." I am sorry, but I made an error in the calculations at the end of page 1159. The last paragraph should be as follows:

The total charge of all the orbital electrons in the formation of the earth is then

$1.721 \times 10^{51} \times -4.8 \times 10^{-10}$
$= -8.2608 \times 10^{41}$ absolute electrostatic units, or

$1.721 \times 10^{51} \times -1.6 \times 10^{-20}$
$= -2.7536 \times 10^{31}$ absolute electromagnetic units and the mass of these electrons is

$1.721 \times 10^{51} \times 9.1066 \times 10^{-28}$
$= 1.567 \times 10^{24}$ grams.

I regret this mistake.

Very truly yours,

E. J. MOMMO (AM '13, M '24, Member for Life)

Atomic Nucleus Theorem

To the Editor:

By letter in the December 1958 issue of *Electrical Engineering*, E. J. Mommo rejects Dr. Grebe's particle cohesion theorem, preferring the classical electric-charge—with variation—as atomic binding force.

As we never see electrons or protons, no one knows exactly what they are. What we visualize are wake effects, and not the very entities themselves. There never is a clear picture given of just how this electric charge relates to the rest of the atom.

For example: the electric charge of the earth has little or no relationship to the gravity binding force holding the earth in orbit. And this seems equally true of the atom and its electron volts.

Since particles have mass, evidently gravity functions within the atom. But we cannot have any sensible concept of the vast all-pervading grid which holds the universe together, if we deal only in electron volts and not in gravity, all of which originates in particles. This is true whether gravity is autochthonously generated within electrons, or is the d-c—or static—stress-residue of ultrahigh frequency (10^{24} cps) rotating charges.

Sincerely,

D. J. STRUVEN (AM '43)

NEW BOOKS

The following new books are among those recently received at the Engineering Societies Library. Unless otherwise specified, books listed have been presented by the publishers. The Institute assumes no responsibility for statements made in the following summaries, information for which is taken from the prefaces of the books in question.

ANALOG SIMULATION. By W. J. Karplus. McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York 36, N.Y., 1958. 434 pages, 6¼ by 9¼ inches, bound. $10. A comprehensive survey of analog techniques and systems for solving field problems is given in this book. The first part deals with the mathematical principles and techniques of immediate and direct interest in solving partial differential equations by electric analogs. This is followed

by a comprehensive study of the various methods of simulating field problems by analogs. The basic operation of each system is described in some detail along with auxiliary techniques found useful. The concluding section is concerned with the solution of typical engineering problems.

CREATIVE THINKING. By C. S. Whiting. Reinhold Publishing Corporation, 430 Park Ave., New York 22, N.Y., 1958. 168 pages, 5 by 7½ inches, bound. $3.95. The major portion of the book is concerned with operational techniques of creative thinking, including group discussion methods and analytical or mechanical techniques that groups have found useful in stimulating new ideas. Among those methods presented are the Gordon technique and brainstorming. The book concludes with descriptions of programs used by various corporations.

DYNAMICAL ANALOGIES. By H. F. Olson. Second edition. D. Van Nostrand Company, Inc., 120 Alexander St., Princeton, N.J., 1958. 278 pages, 6¼ by 9¼ inches, bound. $6.75. This is a new edition of a work dealing with dynamical analogies among electrical, mechanical (rectilineal and rotational), and acoustical systems. The subject matter is developed in stages from the simple element through a complex arrangement of multielement systems. As an aid in establishing analogies, a complete theme is depicted in each illustration. A new chapter has been added on the magnetic analogy as well as two chapters on analogies in the fields of noise, distortion, and feedback. The chapter on mobility has also been enlarged.

FERNWIRKTECHNIK II. Published as Nachrichtentechnische Fachberichte, Vol. 10 by Friedrich Vieweg & Sohn, Braunschweig West Germany, 1958. 85 pages, 8¼ by 11¾ inches, paper. 14 DM. This group of 16 papers, presented at a convention on remote control by telemetry, covers telecontrol equipment for air transport, street traffic regulating installations, mine signaling, electric power supply, water level in sewage works, etc. There are also general papers on topics such as phase-angle measuring equipment for d-c currents and selective telemetering by the impulse code method.

INDUSTRIAL CARBON AND GRAPHITE. Published by the Society of Chemical Industry, London SW 1, England, distributed by the Macmillan Company, 60 Fifth Ave., New York 11, N.Y., 1958. 630 pages, 8¾ by 11 inches, bound. $25.75. These papers, read at a 1957 conference held in London, cover the following aspects: physical properties; manufacture; crystal structure; surface chemical properties and reactivity; electrical behavior and applications; graphite in the nuclear power industry; and mechanical, chemical, and metallurgical applications.

INDUSTRIAL TELEVISION. By H. A. McGhee. D. Van Nostrand Company, Inc., 120 Alexander St., Princeton, N.J., 1957. 120 pages, 5 by 7½ inches, bound. $4. The first part of the book deals with the choice of cameras as well as with the principles of pick-up devices from the flying spot scanner to the photoconductive type tube. This is followed by the design of associated control equipment, including synchronizing and blanking pulse generation, time bases, and remote-control facilities. The second part deals with specific applications such as underwater television, stereoscopic systems, and television microscopy.

MAGNETIC AMPLIFIERS: THEORY AND APPLICATION. By Sidney Platt. Prentice-Hall, Inc., 70 Fifth Ave., New York 11, N.Y., 1958. 238 pages, 6¼ by 9¼ inches, bound. $7. The fundamentals of magnetism, electromagnetism, and electromagnetic induction are discussed in the preliminary chapters of this book, followed by a description of the theory, operation, and application of saturable reactors and magnetic amplifiers in both feedback and nonfeedback cases. Present commercial and industrial uses are presented in detail as are the advantages and disadvantages of the magnetic amplifier.

PHYSICAL METALLURGY OF URANIUM. By A. N. Holden. Addison-Wesley Publishing Co., Inc., Reading, Mass. 1958. 262 pages, 6¼ by 9¼ inches, bound. $5.75. This comprehensive treatment studies uranium in terms of fundamental properties and mechanisms. Among those aspects studied are radioactivity and nuclear reactions, crystallography, physical and chemical properties, mechanical properties, deformation, recrystallization and grain growth, transformations, diffusion in uranium systems, radiation damage to uranium, thermal-cycling growth, and metallography. An appendix provides phase diagrams for binary uranium-alloy systems. This is a volume in the Atoms for Peace presentation set.

THE PHYSICAL THEORY OF NEUTRON CHAIN REACTORS. By A. M. Weinberg and E. P. Wigner. University of Chicago Press, Chicago 37, Ill., 1958. 801 pages, 6¼ by 9½ inches, bound. $15. A scholarly account of the mathematical and physical theory underlying the design of nuclear power reactors, the book is divided into four parts covering (1) the nuclear physics of chain reactors, (2) the transport theory of neutrons, (3) general reactor theory, and (4) heterogeneous reactors. Particular features are the discussions of the new fields of resonance and high-energy reactors, and of heterogeneous reactor physics.

PROGRESS IN SEMICONDUCTORS: VOLUME THREE. Edited by A. F. Gibson and others. John Wiley and Sons, Inc., 440 Fourth Ave., New York 16, N.Y., 1958. 210 pages, 6¼ by 9¼ inches, bound. $8.50. This is a selective review of current developments in the field of semiconductors that discusses the following topics: the magnetoresistivity of germanium and silicon, electronic conductivity of silver halide crystals, silicon junction diodes, lifetime of excess carriers in semiconductors, chemical purification of germanium and silicon, scattering and drift mobility of carriers in germanium, and electronic processes in cadmium sulphide.

PROJECT SHERWOOD: THE U.S. PROGRAM IN CONTROLLED FUSION. By A. S. Bishop. Addison-Wesley Publishing Co., Inc., Reading, Mass., 1958. 216 pages, 6¼ by 9¼ inches, bound. $5.75. This is the first unclassified report on the controlled thermonuclear effort in the United States. Beginning with the basic principles involved in a fusion reaction, it continues with the various methods now being studied to control thermonuclear energy with the hope of eventually producing net power. Methods such as pinch, stellerator, magnetic mirror, and molecular ion ignition are explained. This is a volume in the Atoms for Peace presentation set.

PHYSICAL ACOUSTICS AND THE PROPERTIES OF SOLIDS. By W. P. Mason. D. Van Nostrand Company, Inc., 120 Alexander St., Princeton, N.J., 1958. 402 pages, 6¼ by 9¼ inches, bound. $9. An introduction to the uses of wave transmission in solids, the book discusses both engineering applications and analytical uses. Part one deals with basic principles and engineering applications. It begins with transducers used to generate waves in solids and continues with instruments for measuring attenuation, velocity, and characteristic impedances of solids. It concludes with high- and low-intensity applications of wave transmission. Part two is concerned with analytical uses and presents such topics as phenomenological models for wave propagation, thermal damping, grain scattering, domain motion effects, interstitial diffusion effects, high- and low-amplitude dislocation effects, sound transmission in single-crystal quartz and glasses, and sound damping by free electrons.

REACTOR FUEL TECHNOLOGY. Edited by E. A. Wiggin. Atomic Industrial Forum, Inc., 3 E. 54th St., New York 22, N.Y., 1958. 120 pages, 8½ by 11 inches, paper. $5. Papers discussing enriched and natural uranium systems, blanket fuel, metal and alloy elements, oxide elements, zirconium and zircaloys, stainless steels, and aluminum alloys are included. The papers were delivered at a 1958 meeting at St. Petersburg Beach, Fla.

READINGS IN LINEAR PROGRAMMING. By S. Vajda. John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N.Y., 1958. 99 pages, 5¾ by 8¾ inches, bound. $3. Practical applications of linear programming are worked out in detail so as to provide a clear outline of the basic concepts involved. Among those areas studied are transportation, production scheduling, personnel assignment, ship scheduling, routing aircraft, investment, gasoline blending, and warehousing. The author has included enough theory to make the book self-sufficient.

SCIENTIFIC USES OF EARTH SATELLITES. Edited by J. A. Van Allen. Second edition. University of Michigan Press, 412 Maynard St., Ann Arbor, Mich., 1958. 316 pages, 7 by 10¼ inches, bound. $10. The present edition has been enlarged to the extent that it may be considered almost a handbook on earth satellites. Those areas most extensively revised are the orbit of a small earth satellite, insolation of the upper atmosphere and of a satellite, meteorological measurements and measurements of the earth's magnetic field from a satellite vehicle, ionospheric structure as determined by a minimal artificial satellite, and measurements of interplanetary dust.

SEMICONDUCTORS AND PHOSPHORS. Proceedings of the 1956 International Colloquium. Edited by M. Schön and H. Welker. Interscience Publishers, Inc., 250 Fifth Ave., New York 1, N.Y., 1958. 684 pages, 6¼ by 9¼ inches, bound. $16.50. This collection of papers deals with a wide variety of aspects of the subject, including growth and defects of semiconductor crystals, the incorporation of foreign atoms in crystalline solids, irradiation of semiconductors, thermoelectrical effects in semiconductors, surface effects on the diffusion of impurities in semiconductors, generation of imperfections by thermal stress, measurement of minority carrier lifetime by the phase shift of photoconductivity, photon emission from breakdown in silicon, and recent investigations on the electroluminescence of gallium phosphide. The papers are in English, French, or German.

SOLID FUEL REACTORS. Edited by J. R. Dietrich and W. H. Zinn. Addison-Wesley Publishing Co., Inc., Reading, Mass., 1958. 844 pages, 6¼ by 9¼ inches, bound. $10.75. The book reviews the basic concepts, present status of development in the United States, and the technical outlook for five projected solid fuel nuclear power reactor types. These are the fast-neutron power breeders, heavy water reactors, gas-cooled reactors, organic moderated and cooled reactors, and a thermal reactor for recycling plutonium. The information presented ranges from well-established experimental, theoretical, and developmental results to analyses intended to provide direction for future work. This is a volume in the Atoms for Peace presentation set.

STATIC ELECTRIFICATION. By L. B. Loeb. Springer-Verlag, Berlin, West Germany, 1958. 240 pages, 6¾ by 10 inches, bound. DM 48. A study of the various processes leading to static electrification, the book includes discussions of static electrification by the electrolytic process, the contact potential difference or Volta potential, static changing by spray electrification, mechanisms of electrification on solid-to-solid contact, and processes involving ionization of gases. A concluding section deals with static elimination and the use of electrostatic dischargers.

SYMPOSIUM ON BRITTLE FAILURE OF ROTOR FORGINGS. Published by the American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa., 1958. 43 pages, 6 by 9 inches, paper. $2. Papers on the requirements of rotor forgings for turbines and generators, with particular reference to inspection and testing are given. These were presented at the Special Meeting for Delegates to the World Metals Congress in 1957.

Library Services

ENGINEERING Societies Library books may be borrowed by mail by AIEE members for a small handling charge. The Library also prepares bibliographies, maintains search and translation services, and can supply a photoprint or a microfilm copy of any item in its collection. Address inquiries to R. H. Phelps, Director, Engineering Societies Library, 29 W 39 St., New York 18, N. Y.

SYNTHESIS OF LINEAR COMMUNICATION NETWORKS. By Wilhelm Cauer; translated by G. E. Knausenberger. Second edition. McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York 36, N.Y., 1958. 866 pages, 6¼ by 9¼ inches, bound. $17. This is a translation from German of a standard work dealing with network design. In the present edition, the two volumes of the original are bound into one. Volume one contains a basic exposition of network analysis and synthesis, as well as a discussion of the image-parameter method. An appendix presents a collection of formulas and practical means of filter design with tables, design charts, and examples. Volume two discusses the insertion-parameter design method, band-separation networks, and network equivalence. Appendixes provide the mathematical foundations of circuit theory including the Chebyshev approximation method.

TECHNIQUES OF PLANT MAINTENANCE AND ENGINEERING. Published by Clapp and Poliak, Inc., 341 Madison Ave., New York 17, N.Y., 1958. 211 pages, 8½ by 11¼ inches, bound. No price given. The volume is comprised of conference papers presenting the latest methods and practices in the maintenance field in general, and in specific industries and plants of various sizes. Topics covered include welding, electric power bills, maintenance in small plants, labor relations, preventive maintenance, planning and scheduling, electric motors, sanitation objectives, automation, cost control, and preventing air and water pollution. Proceedings of the Technical Sessions of the 9th National Plant Maintenance and Engineering Show, 1958.

U.S. RESEARCH REACTOR OPERATION AND USE. Edited by J. W. Chastain, Jr. Addison-Wesley Publishing Co., Inc., Reading, Mass., 1958. 366 pages, 6¼ by 9¼ inches, bound. $7.50. The research reactor is studied as a means of providing a strong source of neutrons and gamma rays for physical research, irradiation testing, and producing radioactive isotopes. The principal emphasis in the book is on the advantages and disadvantages of different reactors and on the costs of acquiring and operating a research reactor facility. Each type of research reactor is described in detail and analyzed in relation to specific needs. This is a volume in the Atoms for Peace presentation set.

TECHNICAL LITERATURE

The following recently issued technical literature may be of interest to readers of *Electrical Engineering*. All inquiries should be addressed to the issuers

PILOT. Published for the first time in January 1959, *Pilot* (Permutation Indexed Literature of Technology) is a monthly index of current technical literature on electronics, computers, automation, and avionics. With the use of data-processing machines, all significant words of technical article titles are alphabetically indexed. Annual subscription rate is $60. The periodical may be ordered from Sol Grossman, president, Permutation Indexing, Inc., P.O. Box 25075, Los Angeles 25, Calif.

WELDING TYPE 347 STAINLESS STEEL PIPING AND TUBING. Bulletin #43. Written by G. E. Linnert and prepared under the auspices of the Welding Research Council (WRC), the report is a comprehensive review of information on the welding of Type 347 stainless steel piping and tubing. Both published and previously unpublished data are included. An account is given of the origin and development of columbium stabilized stainless steel to provide familiarity with the actual chemical composition of the Type 347 grade as it is currently produced. Facts are supplied on microstructure and properties of wrought material, castings, and weld metal which later help explain the properties of welded joints. The main portion of the report is devoted to welding procedures and joint properties. Welding defects are thoroughly covered as to cause and cure. The 103-page book may be ordered from American Welding Society, 33 W. 39th St., New York 18, N.Y., or from WRC, 29 W. 39th St., New York 18, N.Y.

EIA STANDARDS. Three new recommended standards for the electronics industry and the second of the specifications for military components to be issued by the Electronic Industries Association (EIA) have been made available to industry. The new standards are: RS-168-1, Dimensional and Electrical Characteristics Defining Tube and Transistor Sockets (an addendum to RS-168), 90¢; RS-185-1, Dimensional and Electrical Characteristics Defining Sockets for Printed Circuits (an addendum to RS-185), $1.65; and RS-213, Test Point Locations for Printed Wiring Assemblies (new material), 25¢. The second specification for military components, SMC-2, issued by the EIA Engineering Department, is Electrical Wire, Insulated, High Temperature, $2.35. These standards and specifications may be obtained through the EIA Engineering Dept., 11 W. 42nd St., New York 36, N.Y. (A minimum charge of $1 is made on all orders.)

PROCEEDINGS OF THE NATIONAL SYMPOSIUM ON EXTENDED RANGE & SPACE COMMUNICATIONS. Because of the great interest indicated by those who attended the symposium, which was held in Washington, D.C., in October 1958, it was decided to publish the Proceedings. The symposium was sponsored by the Professional Groups on Antennas & Propagation and Communications Systems of the Institute of Radio Engineers. Copies of the Proceedings are available at $2 from J. J. Renner, c/o Jansky & Bailey, 1735 DeSales St., NW, Washington 6, D.C.

OTS REPORTS. Publications recently made available to the public through the Office of Technical Services include: "Dynamic Systems Synthesizer," *PB 151137*, by E. C. Hutter and others, Radio Corporation of America for Wright Air Development Center, U.S. Air Force, 1956, price $3.50, which reviews the development of components for an all-electronic analog computer facility described as sufficient to simulate modern guided missile systems; and "The Literature of Space Science and Exploration," *PB 131755*, compiled by M. Benton, U.S. Naval Research Laboratory, 1958, price $4, which is a bibliography of 2,274 references to published unclassified information concerning the more scientific aspects of space exploration, both theoretical and applied, covering the period 1903-58. Both publications may be ordered from OTS, U.S. Department of Commerce, Washington 25, D.C.

1957 SUPPLEMENT TO BIBLIOGRAPHY & ABSTRACTS ON ELECTRICAL CONTACTS, STP 56-L. This bibliography covers papers on the subject of electrical contacts published from October 1956 through October 1957. It brings the total number of references in this series of bibliographies to over 2,600. The reader will find both author and subject indexes, an extensive key to abbreviations used, and corrections and additions for the period 1934-55. Copies of the 1957 supplement are $1.75 each; the original volume, STP 56-G, and its five supplements may be obtained for $10 each set. These books may be obtained from American Society for Testing Material, Headquarters, 1916 Race St., Philadelphia 3, Pa.

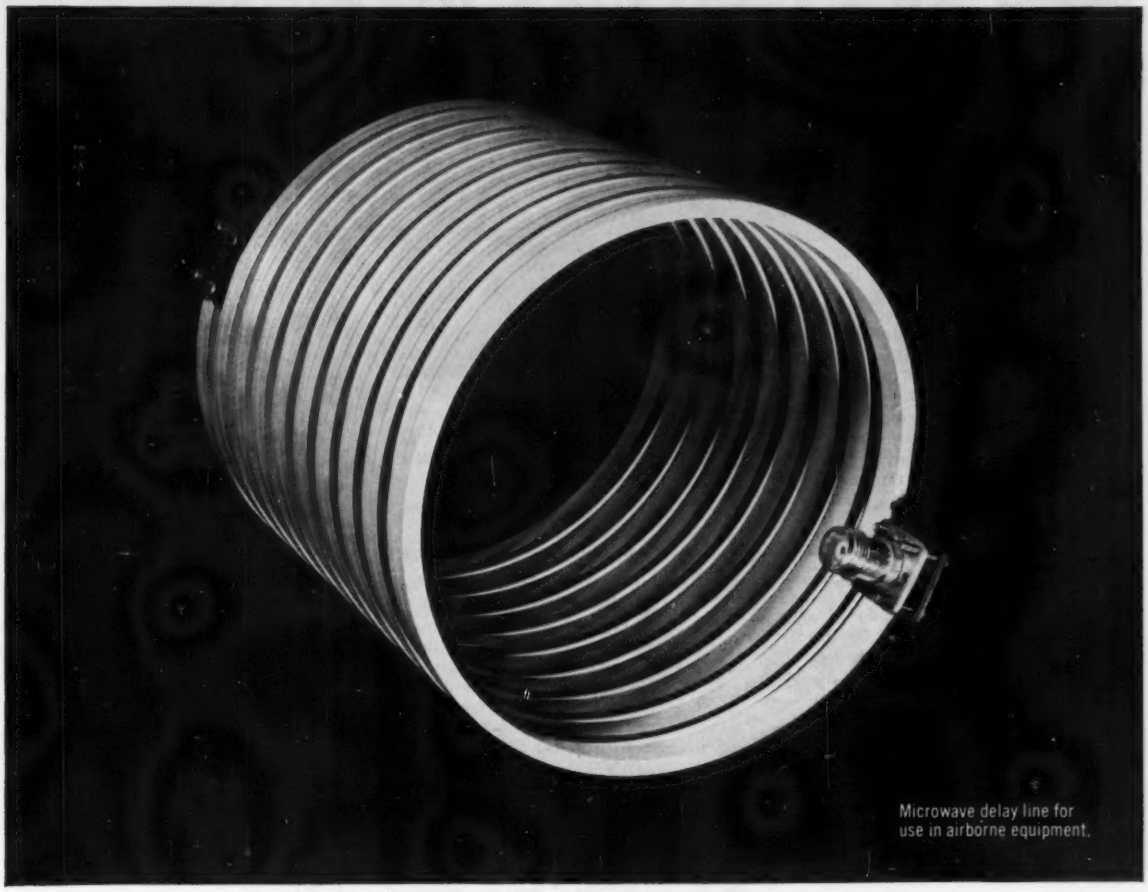
TABLES OF DIELECTRIC DISPERSION DATA FOR PURE LIQUIDS AND DILUTE SOLUTIONS. By Floyd Buckley and A. A. Maryott, this publication contains tabulations of primary dielectric dispersion data and derived characteristic dispersion parameters for pure liquids and dilute solutions. Tabulations are given for almost 200 substances in the liquid state and for dilute aqueous and nonaqueous solutions with more than 150 solutes. Four of the six tables are for pure liquids, two containing summaries of the derived dispersion parameters and two the primary data. The remaining two tables contain the numerical data and the derived dispersion parameters for dilute aqueous and nonaqueous solutions. The section on graphs supplements the tables for pure liquids and contains reproductions of pertinent data that are available only in the form of graphs. The tabulation of this data is part of a general program at the National Bureau of Standards for the critical evaluation and compilation of data from selected fields of physics and chemistry. The pamphlet, National Bureau of Standards Circular 589, is available at 50¢ from Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C.

INVENTIONS WANTED BY THE ARMED FORCES. Published by the National Inventors Council (NIC), U.S. Department of Commerce, this publication lists technological puzzles which have stumped military scientists in the hope that civilian inventors may produce the solutions. Some of the problems listed for the field of electricity and electronics include: a highly directive antenna to increase the range of a radar set or communication equipment, especially in the microwave frequency bands between 1,000 and 30,000 megacycles; a device for receiving electromagnetic radiation in the 9-14 micron region with a response time of microseconds, which should operate at normal temperatures; and a sharply unidirectional device of small size in relation to wavelength for sound detection on signals as low as 5 cycles per second. Free copies of "Inventions Wanted," as well as the 1957 basic edition listing more than 300 problems, may be obtained by writing the NIC, U.S. Dept. of Commerce, Washington 25, D.C. Suggested solutions to problems also should be addressed to the Council, which is the Government's official clearinghouse for processes and inventions of potential value to the Armed Forces.

PROCEEDINGS OF THE 14TH ANNUAL MEETING OF THE METAL POWDER ASSOCIATION. The 16 papers collected in the proceedings delve into powder metallurgy topics from the state of the art in the USSR to new methods of producing high-performance radio frequency filter elements. Other papers deal with powder metallurgy's relationship to or effect on metal cutting tools, sintering atmospheres, rockets and missiles, barrel finishing, slip casting methods, and other recent techniques. Single copies of the 125-page illustrated proceedings are available at $4 each from Metal Powder Industries Federation (formerly Metal Powder Association), 130 W. 42nd St., New York 36, N.Y.

HIGHWAY LIGHTING REFERENCE GUIDE. Based on American Standard Practices for Street and Highway Lighting, as developed by the Illuminating Engineering Society for the American Standards Association, the guide was prepared because of the high percentage of fatal and nonfatal accidents which occur at night on America's highway network. The book was designed for use by highway and lighting engineers, as well as officials concerned with this field. Available light sources are reviewed in detail first: incandescent, mercury, and linear fluorescent lamps are next discussed, with appropriate illustrations and tables. A second section, devoted to luminaires, reviews fundamentals of design, elements used, light distribution, common types in use, quality specifications, standards and tests, and installation and maintenance. Lengthy discussion, with complete position diagrams, is given to various highway "situations," such as intersections, expressways, tunnels, bridges, high traffic density sections, and urban area approaches. Copies of the guide are available, at $1, from the Safe Highway Lighting Committee of the Street and Highway Safety Lighting Bureau, 1400 Terminal Tower, Cleveland, Ohio, or 155 E. 44th St., New York, N.Y.

HOW TO DESIGN AND SPECIFY PRINTED CIRCUITS. This manual, released by the Institute of Printed Circuits (IPC), is a practical guide for the design engineers and purchasing executives in the appliance, automotive, electrical manufacturing, and electronics industries. The book presents a general technical explanation of the sequence in adapting electrical and electronic wiring circuits to a single or coplanar printed wiring connecting structure. Over 60 pictures and illustrations are included. Topics reported on include: the advantages of printed circuits, layout and design considerations, selection of materials and components, reliability, terminology and definitions, production methods, process limitations, multiple soldering techniques, switch plates and commuter discs, art work, finishes, service and repair, and printed circuit assembly. Copies of the book may be purchased from IPC, 27 E. Monroe St., Chicago 3, Ill., at $5 per copy.



Microwave delay line for use in airborne equipment.

MICROWAVE RESEARCH

The expanding role of electronic equipment in modern military operations has given high priority to microwave research. No field today offers greater challenge to the scientist and engineer.

In support of current electronic countermeasures programs and in anticipation of future systems requirements, Ramo-Wooldridge Division is engaged in microwave research to develop new techniques and to refine conventional components.

Research is under way at Ramo-Wooldridge for new methods and new designs to reduce substantially the over-all size, weight and complexity of electronic equipment for both airborne and ground-based uses.

For example, the low-loss delay line in the photograph above was designed, developed and manufactured by Ramo-Wooldridge for use in airborne equipment. Packaged for use in the system for which it was designed, this miniature ceramic unit weighs less than two pounds. It replaces a component which weighed more than twenty pounds and occupied more than five times as much volume.

Special opportunities exist for those with qualified experience in microwave research—in technique evaluation, component development, and design of such systems equipment—at Ramo-Wooldridge.

Engineers and scientists are invited to explore openings at Ramo-Wooldridge in:

Electronic Reconnaissance and Countermeasure Systems
Infrared Systems
Analog and Digital Computers
Air Navigation and Traffic Control
Antisubmarine Warfare
Electronic Language Translation
Information Processing Systems
Advanced Radio and Wireline Communications
Missile Electronics Systems

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New and Improved Products . . .

Wide Range D-C/A-C Power Supplies . . .

A line of variable-output unregulated power supplies called RC-Nobatron Rangers provides both d-c and a-c outputs for general purpose laboratory or production-line test-bench applications. D-c outputs range from zero to 36 and from zero to 150 volts; a-c outputs range from zero to 130 volts. Consisting essentially of a conveniently packaged variable autotransformer, rectifier, and filter circuit, the units have exceptionally low internal impedance as a result of conservatively rated components. Complete specification data is contained in Product Data Sheet *DC270*. **Sorensen & Company, Inc., Richards Ave., South Norwalk, Conn.**

Circle 201 on the card.

3-Kw Ultrasonic Generator . . .

Designed for high-volume, all day production cleaning, the *APT 500* generator will activate up to 6 square feet of transducer area, or 300 gallons of cleaning solution. Ultrasonic cleaning requires no operator attention except for immersion and removal of parts, and generally removes insoluble soils in minutes. Even complicated mechanisms, blind holes, and other involved shapes are thoroughly cleaned, as long as they are in contact with the ultrasonically agitated liquid. **Branson Ultrasonic Corp., 40 Brown House Rd., Stamford, Conn.**

Circle 202 on the card.

High Fidelity Innovation . . .

The Audio Baton enables an audiophile to control to an infinite degree the sounds in the entire audio spectrum from 20 to 20,000 cycles per second. Control is achieved through nine knobs, each covering one of nine octaves within that range. Kettle drums, piccolos, bass viols, or the human voice can be suppressed or accentuated at will. In a public address system the shrill whistle induced by feedback can be virtually eliminated without sacrificing the tonal quality of the lecturer. **Blonder-Tongue Laboratories, Inc., 9 Alling St., Newark 2, N.J.**

Circle 203 on the card.

Transistorized Industrial Computer . . .

A small all-transistor digital computer developed for automatic control of industrial processes has been test-operated for 2,000 hours without component failure. Specifically designed for a variety of industrial uses in the power, chemical, oil, gas, and steel industries, the device is currently being investigated for the control

Courtesy Rex Lowden, A.I.B.P.

of boilers during start-up and shut-down. **Ferranti Ltd., Hollinwood, Lancaster, England.**

Circle 204 on the card.

Multiplier Phototube for Discoveries on Mars . . .

A recent electronic tube development may provide the key in determining whether Mars has sufficient water to support life. A multiplier phototube capable of converting light into an electric current and amplifying the result 2 million times, has been installed by the Office of Naval Research in a 16-inch telescope scheduled to be trained on Mars from a balloon 80,000 feet above the earth's surface. Installed as the eyepiece, this tube will amplify sunlight reflected from the surface of Mars. Scientists will then study the infrared portion of light to determine what part has been absorbed by water vapor in the Martian atmosphere. **International Telephone & Telegraph Corp., Fort Wayne, Ind.**

Circle 205 on the card.

Flight Simulator . . .

A low-threshold, high-response flight simulator has been delivered to the San Diego test facility of Convair, Calif. The 2-axis unit, one of a line of 1-, 2-, and 3-axis units, will enable the accurate testing of airborne electronic components over a full range of flight patterns. The Convair unit accommodates components or systems as large as 12 by 12 by 14 inches and weighs up to 50 pounds. It will subject test components to rates of 200 degrees per second and accelerations of 6×10^4 degrees per second^2. **Task Corp., 1009 E. Vermont Ave., Anaheim, Calif.**

Circle 206 on the card.

Noise Generator . . .

Noise 100 million times greater than the 5 o'clock traffic din can be produced by an electromechanical loudspeaker. Designed to simulate the noise of a rocket engine, the generator helps test critical components that will go into the Titan and Minuteman ICBM nose cone. **Avco Research and Advanced Development Division, 201 Lowell St., Wilmington, Mass.**

Circle 207 on the card.

Continuous Integration Recorder . . .

An electronic strip-chart recorder with continuous integration measures, records, and continuously totalizes any linear variable with respect to time. Although designed primarily for gas chromotography analysis, it can be used to measure flow, continuous weighing systems, electric power line network consumption, and electric current in aluminum pot lines and other electrolytic cell lines. **Brown Instruments Div., Minneapolis-Honeywell Regulator Co., Wayne and Windrim Aves., Philadelphia 44, Pa.**

Circle 208 on the card.

Coded Diodes . . .

An original coding system makes it easy for engineers and technicians relatively inexperienced in semiconductors to select a specific diode on the basis of both the number and the values of characteristics desired. Two major classifications of diodes are being produced, one for general purpose and computer use, the other for special computer applications where 10 operating characteristics are specified. Employing the superior gold-bonded construction in which a gold whisker wire is welded to the germanium pellet, the units are distinguished for their high forward conductance, high back resistance, and fast reverse recovery time. **Ohmite Mfg. Co., 3682 Howard St., Skokie, Ill.**

Circle 209 on the card.

Miniature Dimple Motor . . .

A powerful miniature, squib-actuated dimple motor, which provides positive displacement for the performance of mechanical work is 0.300 inch in diameter and ½ inch long. Actuated by as little as 7,500 ergs, the motor is capable of providing 8 pounds of thrust over a 0.1 inch minimum stroke within an elapsed time of 1 millisecond. **Atlas Powder Co., Ordnance Material Dept., Wilmington 99, Del.**

Circle 210 on the card.

Conductor Harness . . .

Precision wiring can be made a routine affair with this flat, multiconductor and multicolored cable. Interconductor capacitance may be controlled by the relative position of the wires in the cable and is uniform from cable to cable, enabling a harness to be engineered for maximum electrical efficiency. Uniformity of color

(Continued on page 22A)

DON'T GET ME WRONG...I STILL DON'T LIKE STORMS

**"But they don't seem to hit us so hard any more.
Not since polyethylene coated wire came along."**

The lineman's boss also gives polyethylene credit for reducing outages during storms. This tough plastic forms a continuous shield that resists moisture, weathering and aging. It protects the conductor from contact with wind-whipped branches and wires, prevents short circuiting by chance electrical contacts.

Protection is long-lasting. Early installations have shown no deterioration after 11 years exposure to all sorts of weather. And accelerated aging tests point to an expected life as great as 40 years.

In winter, polyethylene coated wire stands up better than other types because it is lighter, has a smaller diameter. It offers less resistance to wind and ice . . . supports a greater weight of ice without breaking.

Easier Installation, too . . .

Polyethylene is easy to handle because it's clean . . . self-lubricating . . . readily stripped. Yet it adheres well, doesn't ruffle when pulled.

Here are some of the applications where polyethylene is giving outstanding service:

- Line wire covering
- Communication cable insulation and sheaths
- Power cable dielectric
- Tree wire covering
- GTO (Neon Sign) Cable
- WD-1 Infantry Field Wire
- Control cable insulation and jacket
- Corrosion protection for metal sheaths
- TV Lead Wire

But all polyethylenes aren't the same. Ask your supplier about the superior weather and stress-crack resistance of coatings made with PETROTHENE® polyethylene resins. You pay no more for PETROTHENE quality.

U.S.I. INDUSTRIAL CHEMICALS CO.
Division of National Distillers and Chemical Corp.
99 Park Ave., New York 16, N. Y.
Branches in principal cities

Makers of PETROTHENE® Polyethylene Resins

For more information circle 13 on reader service card.

NEW!

ROME *TRIMLINE**

PRIMARY DISTRIBUTION SYSTEM

WITH A NEW SIMPLIFIED, STREAMLINED SPACER DESIGN!

A Practical Overhead System. Developed for utility and industrial distribution circuits ranging from 5 to 15 kv, Rome's TRIMLINE* system consists of (1) a unique and highly simplified Plexiglas supporting spacer, (2) extruded black, high molecular weight polyethylene insulated phase conductors (either one, two, or three phase), and (3) a high strength supporting messenger.

This economical method of overhead distribution is recommended for installations where:

- additional circuits are required on a pole
- poles are too crowded
- bad tree and storm conditions cause havoc with open-wire lines
- alleyways prohibit use of crossarms

. . . and especially where a *compact* and *neat-appearing* distribution system is necessary!

System Features New Spacer. Now . . . a new spacer design makes Rome's TRIMLINE* system as reliable as it is practical. The one-piece Plexiglas spacer offers distinct "reliability" features. It has no mating or matching surfaces to form cracks or crevices which collect water or other contaminants. This in turn reduces the possibility of eventual arcing or shorting.

Each spacer is equipped with four "snap-lok" neoprene grommets (adapters). Special molded-in compression rings in each grommet assure a snug spacer-to-cable fit. The constant pressure exerted upon the messenger and conductors restricts the spacer from "traveling" on the line.

The spacer itself is shaped like a diamond with rounded corners and smooth edges. When installed, each of the phase conductors and the messenger are completely contained within the encompassing spacer unit.

Installation of the spacer unit is performed with no tools or special equipment, requires *no* nuts or bolts. And maintenance is just as easy—phase conductors can be removed or added without removing the spacer from the messenger. Spacers are placed approximately thirty feet apart along the entire length of the distribution system.

*T. M. (patent applied for)

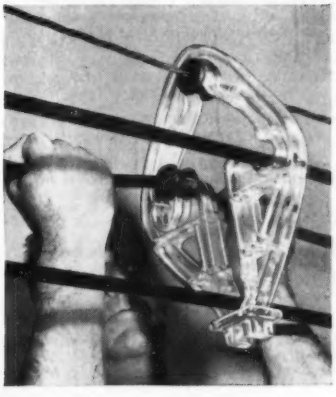
HERE'S WHAT THE TRIMLINE SYSTEM OFFERS YOU:

1. A *single* spacer for 5 to 15 kv range.
2. Abrasion-resistant high molecular weight polyethylene insulation or other suitable materials as specified by the user.
3. Neoprene grommets with molded-in compression rings.
4. A spacer that completely encloses phase conductors and messenger.
5. A high strength supporting messenger that provides storm damage protection, thereby permitting . . .
6. Longer spans—the system messenger permits spans up to 300 feet.
7. Positive phase identification by position in spacer.
8. Lower reactance than conventional open-wire lines.
9. Ease of installation.
10. Neat, compact overhead distribution. Better public relations.

Send in the coupon for our new bulletin on Rome TRIMLINE* Primary Distribution System.

For more information circle 14 on reader service card.

SEND FOR FREE BULLETIN!



ROME CABLE

CORPORATION

Dept. T, Rome, N. Y.

I want more information on the Rome TRIMLINE Primary Distribution System. Rush me my free copy of Bulletin RCP-790.

Name .....

Title .....

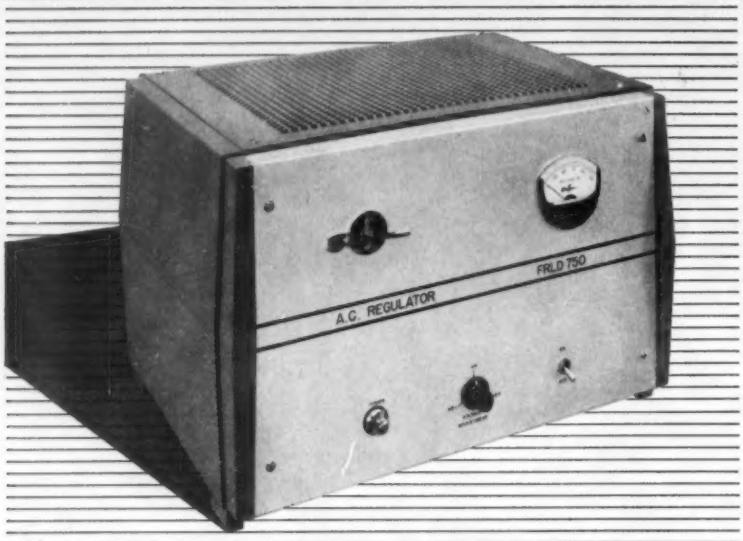
Company .....

Street .....

City ..... *State* .....

NEW IDEAS IN PACKAGED POWER

for lab, production test, test maintenance, or as a component or subsystem in your own products



New, fast, a-c regulator cuts line & load transients 18 db

• Steady-state line and load regulation to ±0.5% • Transients attenuated at least 8:1 (18 db) • Fast response—less than 1 cycle (0.02 sec) for 63% recovery • Less than 0.35% distortion

The new Sorensen Model FRLD750 fast-response, low-distortion a-c regulator is ideal for critical applications like null testing, meter calibration, and the powering of pulse-type circuits, such as those used in computers, where false triggering is not permissible.

Since there is no phase shift between input and output, the FRLD750 can also be used in multiples for the regulation of multi-phase power. Line and load transients are reduced by at least 8:1, regardless of their magnitude. Both cabinet and 19" rack-mounting models available. Write for technical data or see your Sorensen representative.

And don't forget, Sorensen engineers will be glad to discuss your special power requirements with you. They can help you select the proper a-c or d-c power supply, regulator, or frequency-changer from the widest transistorized line on the market, or assist you in designing special power systems. 8.39

Sorensen

SORENSEN & COMPANY, INC.

Richards Avenue, South Norwalk, Connecticut

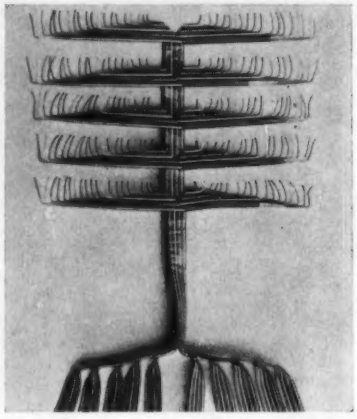
WIDEST LINE OF CONTROLLED-POWER EQUIPMENT FOR RESEARCH AND INDUSTRY

IN EUROPE, contact Sorensen-Ardag, Zurich, Switzerland. **IN WESTERN CANADA,** ARVA. **IN EASTERN CANADA,** Bayly Engineering, Ltd. **IN MEXICO,** Electro Labs, S. A., Mexico City.

For more information circle 15 on reader service card.

New & Improved Products

(Continued from page 18A)



and position allows quick location of circuits from one end to the other. **Spectra-Strip Wire & Cable Corp., Garden Grove, Calif.**

Circle 211 on the card.

Vacuum Power Switches . . .

These switches are distinguished by much higher voltage and current ratings through the use of larger contacts and improved processing techniques. Individual switches will handle recovery voltages up to 48 kv peak when interrupting 600 amperes rms. They may be used in series for operating voltages up to 230 kv rms and can handle continuous current ratings up to 600 amperes and momentary surge current ratings up to 20,000 amperes. These switches also interrupt currents up to 4,000 amperes. Vacuum power switches are useful in capacitor and load-break switching, fault-current interruption, transformer magnetizing current and inductive switching, and high-voltage transmission line dropping. **Jennings Radio Mfg. Corp., 970 McLaughlin Ave., San Jose 8, Calif.**

Circle 212 on the card.

Manual-Reset Circuit Breaker . . .

A remote-mounted circuit breaking unit, adaptable to fractional hp motors on washing machines, dryers, dishwashers, disposal units, electric power lawn mowers, and other appliances, provides motor protection in ratings from 5 to 20 amperes. Overloads are prevented by a snap-action thermal element that trips when the current exceeds a predetermined limit. An insulating barrier holds the contact points apart until the plunger is reset. **Mechanical Products, Inc., Jackson, Mich.**

Circle 213 on the card.

Galvanometer and Phototube Amplifier . . .

Small fractions of a microvolt may be detected and amplified with this low-noise

(Continued on page 24A)

Now You Can Get 26 Weeks of News Like This for only $2.67

Here's your opportunity to try the news magazine which 1,000,000 readers are finding so useful

NOW YOU CAN GET U. S. NEWS & WORLD REPORT for about ten cents an issue.

You can get all the news you look for in a news magazine — plus the "extras" which make this magazine the most quoted, most useful news publication in America.

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If you do not decide that it can do the same for you, this trial will cost you nothing.

U. S. NEWS & WORLD REPORT has become the nation's fastest growing news magazine. Why? What's so different about it?

Perhaps it's because the editors not only report everything you expect to find in a news magazine, but they go further and seek to answer the questions raised in your mind: "What does the news mean to me? My work? My family? What caused it? Where is it leading?"

Here is a new dimension of news reporting, combining breadth of coverage with unusual depth of exploration and understanding. Here are just a few of the subjects in which readers have been briefed in recent weeks:

1. What's Ahead for Business Now
2. How To Save on Your '58 Taxes
3. What Experts Say About Investing in Today's Market
4. Encouraging News for Heart Patients
5. What the New Congress Will Do to You and for You
6. Campaign for 1960 Starts -- with Both Parties Split
7. Providing for Your Family's Future: What Fathers Should Know
8. Next Big Tests for School Integration
9. Are Strikes Delaying the Business Upturn?
10. How to Protect Yourself Against Inflation
11. In Britain -- a Comeback for "Conservatives"
12. Nixon's New Role
13. Halting H-Bomb Tests: What's at Stake
14. Farewell to Passenger Trains?
15. War Dangers in the Middle East
16. New Federal Aids for Small Businessmen
17. A Billion People in U.S.? The Coming Population Explosion
18. Is This a Good Year to Buy a House?
19. Jet Planes for the Airlines...Where & When You Can Fly
20. Analyzing Investments of Officials in Their Firms' Stock
21. 4 Billions for Roads -- Big Boost for Business in '59
22. How Ike Will Deal with Democratic Majorities in Congress
23. U.S. Space Program: First the Moon, Then Mars & Venus
24. When Public Schools Close: Report From 4 Southern Cities
25. All About Current Tax Rules on Expense Accounts
26. Double-Barrelled Medical Advance for Arthritis Sufferers
27. "Hate Bombings": What's Being Done to Stop Them?
28. Who Gets the 6.2 Billions for Military Research?
29. Where the Big Investors Are Putting Their Money
30. Big Consumer Spending: Paving the Way for Recovery
31. Can Your Child Get a Federal Loan for a College Education?
32. Nasser-Khrushchev: "Partnership" That Spells Trouble
33. Timetable for Recovery, Industry by Industry
34. What U.S. Has Learned from Satellites in Space
35. How To Make 5% on Your Money
36. Your Food Bill in the Months Ahead
37. De Gaulle's Blueprint for a Stronger France
38. Is a National Sales Tax Coming?
39. 2 Million More Jobs: Effect on '59
40. New Trouble for the U.S. in Argentina
41. "United Front": Newest Way to Fight Strikes
42. Behind Red China's "Hate America" Drive
43. U.S. Schools -- Getting Tougher and Better
44. New Ways to Save on Business Taxes
45. What Opening of St. Lawrence Seaway Means
46. Soon from Detroit -- Smaller, Cheaper Cars
47. Profits: New Records in Prospect for 1959
48. New Ways to Get Protection from Insurance
49. If You Want to Live to a Ripe old Age --
50. Full Report on Alaska
51. How to Handle Your Money Now
52. Credit Cards: What's Good and Bad About Them
53. Nasser's Next Move -- Closing the Ring Around Israel?
54. 5 Years of Integration...Report on Washington Schools
55. Political Hopefuls for the 1960 Presidential Race
56. Latest Rules for Calling Military Reservists
57. How Well Prepared for War Is the U.S.?
58. Khrushchev's Game in East Germany
59. The Big Increase in Federal Spending...Who's Responsible?
60. Stock Vs. Bond Yields: How They Now Compare
61. How Well Are the '59 Cars Selling?
62. Where to Get the Most for the Dollars You Spend
63. Polluted Air in Our Cities: A Cause of Cancer, Heart Disease?
64. If You're Planning to Borrow Money --
65. What Husbands & Wives Should Know About Family Finances
66. Today's War: How Reds Stir Trouble in 72 Countries
67. Best Job Opportunities for College Graduates

Every issue of U. S. NEWS & WORLD REPORT brings you news like this -- news you can use, news you didn't know and can't get anywhere else. Interviews with famous news-makers in the fields of politics, government, foreign affairs, labor, science, industry, health. Not one, but five newsletters (which many subscribers consider to be alone worth more than the magazine's cost). Special reports based on weeks or months of study by experts. Historic speeches, press conferences, and other important documents of our time printed in full. Many picture-charts and other visual techniques for summarizing valuable facts quickly.

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HOW TO HANDLE YOUR MONEY NOW

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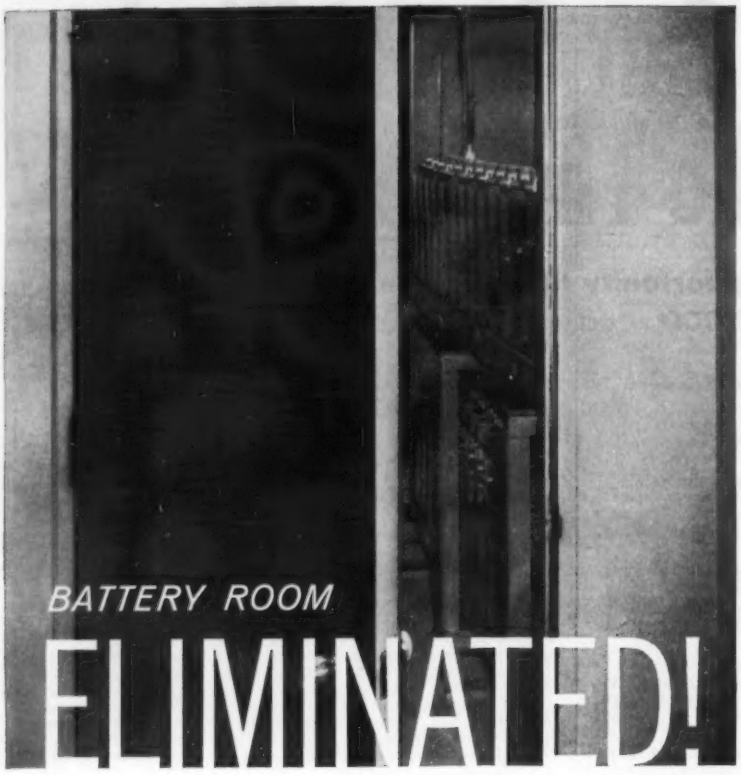
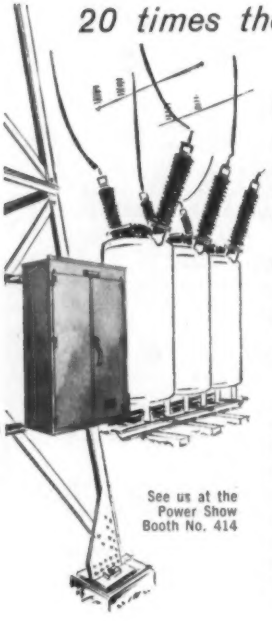


Non-gassing Gulton Power Units deliver
20 times the punch, take 1/20 the space



See us at the Power Show Booth No. 414

POWERED by the world famous Voltabloc *sealed* nickel cadmium battery, the Gulton Power Unit delivers the punch needed for closing and tripping breakers and switchgear—yet takes only a fraction of the space needed by other DC Sources.

Reason for this is the patented sintered plate construction of the sealed Voltabloc battery and its compact specially designed automatic charger. Not only do these give the Gulton Power Unit exceptional electrical characteristics, but they provide additional benefits as well.

Maintenance, for example, and installation costs are eliminated. Since Gulton units are non-gassing as well as small in size, they can be installed right next to equipment with a minimum of wiring—sometimes even within it!

Our field engineers will be happy to help you pick the right unit for the job. For more information on how "BC" Power Units can help save space, maintenance and money—write for Bulletin No. GPU.

ALKALINE BATTERY DIVISION
Gulton Industries, Inc.
Metuchen, New Jersey

Gi

For more information circle 16 on reader service card.

New & Improved Products

(Continued from page 22A)

galvanometer-phototube amplifier, Model *4300*. The signal is fed to the galvanometer through a bridge-tee attenuator deflecting the light beam reflected from the galvanometer mirror. This light, passing through a splitter lens, strikes twin photocells in varying intensities, producing a high gain. **The Geotechnical Corporation, P. O. Box 28277, Dallas 28, Texas.**

Circle 214 on the card.

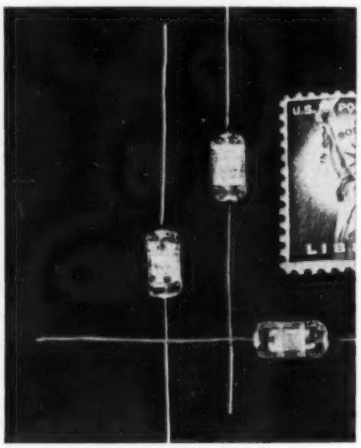
Remote Sequence Control Capacitor Switching . . .

Automatic, centralized control of remote capacitor banks in electrical utility systems can be made by code tones transmitted by carrier current over feeder lines to transistorized receiver-decoders located at remote capacitor sites. When system voltage at its substation bus exceeds preselected limits in either direction, the coder initiates a tone generating device for OPEN or CLOSE signals that are programmed in the desired sequence in which capacitor banks should be added to the line. **Motorola Inc., 4501 W. Augusta Blvd., Chicago 51, Ill.**

Circle 215 on the card.

New Glass Capacitor . . .

Eight of these fusion-sealed *CYF-10* capacitors would fit snugly on a postage stamp. Designed to give peak performance under the most adverse operating conditions, they show no significant change in capacitance or dielectric loss after more



than 1,000 hours in a high-humidity atmosphere. The *CYF* has a capacitance range to 240μμf and a d-c working voltage up to 500 at 125 C. Initial use will be in military communication and detection systems. **Corning Glass Works, Corning, N.Y.**

Circle 216 on the card.

(Continued on page 26A)

no. 7 OF A SERIES

A "SOUND" APPROACH TO RIDING COMFORT

The "tuning out" of excessive shake and vibration by Oldsmobile engineers produces a comfortable, balanced ride that adds thousands of miles to the life of an automobile.

One of the most critical areas of engineering in today's automobile is "ride". It is critical because an unsatisfactory ride means an unsatisfactory automobile. To produce an over-all balanced and smooth ride, free from harshness and fatiguing vibration, Oldsmobile engineers begin the complex task of "tuning" the car in the early stages of a new model program. Not only is ride important from the comfort standpoint, but an improperly "tuned" car can literally shake itself apart after several thousand miles.

The tuning operation is a series of intricate tests that determine a car's "shake" characteristics—where and how much the metal bends and twists. To produce beaming and torsional moments, a mechanical oscillator is attached to the frame and vibrates the car in a frequency range of 7½ to 15 cycles per second. To measure the displacement of the metal, a velocity pick-up is attached directly to the area under study. As the metal vibrates, a signal is produced by the pick-up and is fed to a vibration meter where it is integrated. The resulting signal is then transmitted to an X-Y plotter that instantly converts it into a continuous magnitude-vs.-frequency trace.

With this valuable information, refining can begin by altering the structure of the various component parts. A complex network of infinite variation must be analyzed intensively to produce the mark of quality that stamps every Oldsmobile.

Over the years, Oldsmobile's reputation for quality manufacturing and precision engineering has grown, step by step, until today it is a car of recognized distinction—in a class by itself. Oldsmobile's durability and long service life is further attested to by its continued leadership in resale value. You owe it to yourself to first examine, then test-drive, a truly outstanding automobile—the 1959 Oldsmobile. Visit your Local Authorized Oldsmobile Quality Dealer as soon as possible.

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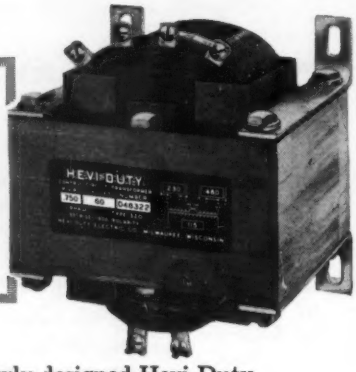
"Complete Semiconductor Power Conversion Systems for any AC to DC application."

▲ Circle 18 on the card. ▼ Circle 19 on the card.

you'll have
SPACE to SPARE
on your panel



. . . when you mount the newly designed Hevi-Duty Type SZO Control Circuit Transformer. Savings in panel space range up to 20 percent over units of equivalent rating. Better yet, you'll have extra inrush capacity (up to 150% more) due to Hevi-Duty's interleaved windings and other new improved proportions of design. New Type SZO transformers range from .050 to 5 KVA.

Write for Bulletin 300 for further details

HEVI-DUTY ELECTRIC COMPANY

HEAT TREATING FURNACES HEVI-DUTY ELECTRIC EXCLUSIVELY

DRY TYPE TRANSFORMERS — CONSTANT CURRENT REGULATORS

MILWAUKEE 1, WISCONSIN

New & Improved Products

(Continued from page 24A)

High-Speed Transistorized Printer . . .

A solid-state line printer which selects, edits, and prints data from a computer or magnetic tape at rates up to 1,500 lines per minute features on-line or off-line operation, buffer data storage, and automatic editing under plugboard control. The system consists of a drum printer and a transistorized control unit. A 100-word memory in the buffer circuit allows simultaneous data loading and final printing while the plugboard permits the operator to program-control the printer system independently of the computer. The printer's vocabulary consists of 51 solid-face characters in lines of 120 positions with a printing density of 10 characters per inch. **Burroughs Corp., Electro-Data Div., 460 Sierra Madre Villa, Pasadena, Calif.**

Circle 217 on the card.

Electronic Corrosion Control Recorder . . .

The exact amount of chemical inhibitor needed to control internal corrosion is often difficult to determine. The usual method is to measure the weight loss of small coupons after lengthy exposure to corrosive action. This instrument can provide an hourly record of corrosion attack and is capable of detecting as little as one millionth of an inch of corrosion. A dual element probe, made of the same material as the one under examination, provides a measure of increased resistance between the element exposed to the corrosive atmosphere and the one protected by a plastic or ceramic coating. **Crest Instrument Co., 11808 S. Bloomfield, Sante Fe Springs, Calif.**

Circle 218 on the card.

One-Shot High-Speed Electronic Switch . . .

Incorporating an electronic circuit of a capacitor, resistor, magnetic core, and diode to produce a single, microsecond-length pulse with each operation, the *1PB600* series of switches eliminate the need of designing special pulse input circuits for high-speed electronic switching devices. The square-wave pulse width is factory adjustable from 0.2 to 2.5 microseconds, and the amplitude from 3 to 60 volts. Contact arrangement is single-pole double-throw. **Minneapolis-Honeywell Regulator Co., Freeport, Ill.**

Circle 219 on the card.

Solid-State Digital Modules . . .

A complete set of solid-state digital logical packages may be combined to

(Continued on page 28A)

resists water...like KERITE INSULATION

It's the **KERITE** *that makes the difference*

KERITE CABLE

30 Church Street, New York 7.
Branches in Ardmore, Pa., Boston, Cleveland, Chicago, Houston, St. Louis, San Francisco, Glendale, Cal.

For more information circle 20 on reader service card.

*

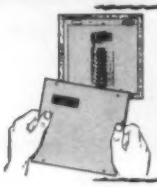
GTC

*an effective, economical industrial communication system designed to provide swift and sure voice communications regardless of distance or surrounding noise conditions.

. . . THE UNITIZED COMMUNICATION SYSTEM . . .

COMPLETELY TRANSISTORIZED AND DESIGNED TO MEET THE CRITICAL REQUIREMENTS OF INDUSTRY

1. An effective, economical industrial communication system designed to provide swift and sure voice communication under adverse environmental conditions such as extremes of temperature and noise.



2. All amplifiers are "plug-in" contributing greatly to ease of installation and MAINTAINABILITY.

3. Transistors and rugged, industrial type components are used throughout. No vacuum tubes or "entertainment" type components of any kind are employed.

4. Central Control cabinet is eliminated thus reducing space requirement to a minimum.

5. ULTRA SIMPLE WIRING PLAN (no shielded cables) and UNITIZED EQUIPMENT with integral terminal facilities make for EASY LOW COST INSTALLATION and LATER EXPANSION.

* GAI-TRONICS TRANSISTORIZED COMMUNICATIONS

GAI-TRONICS
CORPORATION
Dept. B
READING, PENNA.

A SUBSIDIARY OF GILBERT ASSOCIATES, INC.
ENGINEERS AND CONSULTANTS

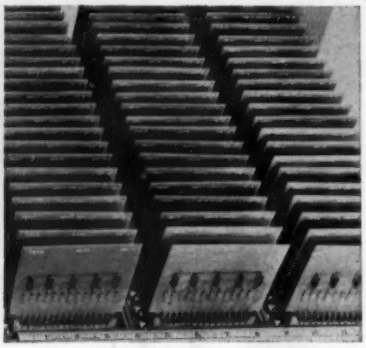
GTC is extremely flexible in application. Write today for a copy of our completely illustrated, descriptive booklet, and name of nearest representative.

For more information circle 21 on reader service card.

New & Improved Products

(Continued from page 26A)

build registers, counters, and other data-handling equipment, including computers. The packages include flip-flops, inverters, gates, drivers, clock generators, etc. These plug-in modules are easily replaceable and can be built into systems of any size. High reliability is achieved through the



elimination of both eyelets and printed circuit connectors. In the illustration, the modules are used in an input buffering system. **Packard-Bell Electronics Corp., Technical Products Div., 12333 W. Olympic Blvd., Los Angeles 64, Calif.**

Circle 220 on the card.

Fractional Distance Measuring Instrument . . .

Designed to measure distances in the 0 to 45,000 micro-inches range with very high accuracy, the electronic micrometer, Type *B-721*, affords a unique method of measuring small distances without physical contact. Measurement is by means of a transformer coupled bridge in conjunction with a noncontacting probe. The distance is measured in terms of the capacitance change between the test surface and the noncontacting probe. This instrument is particularly suited to measurements on rotating objects, and for monitoring distance with reference to a predetermined value. Because no physical contact is necessary, accurate determination of temperature coefficient, moduli of elasticity, rigidity and bulk, Poisson's ratio, and dilation are possible on fragile samples. **Wayne Kerr Corp., P. O. Box 801, Philadelphia 5, Pa.**

Circle 221 on the card.

10-Kw Troposcatter Amplifier . . .

Designated as model *1042-5*, this klystron powered multichannel communication system can deliver 10-kw output when receiving an input signal of 6 watts maximum. The unit can be used in a completely integrated scatter system, or it may be used with other uhf equipment. **National Co., Inc., 61 Sherman St., Malden 48, Mass.**

Circle 222 on the card.

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10. Sheathing for highly sensitive repeater units in transatlantic cable.
11. For oscillation and modulation coils in television transmitters.
12. Control tube in transmitting air signals in power plants, oil refineries, chemical plants, etc.

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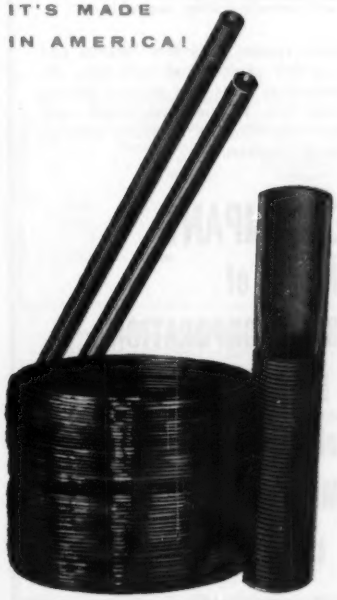

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Wolverine copper and aluminum tubing, for example, is available in straight lengths and coils in both prime surface form or with integral fins (Wolverine Trufin®).

You'll also appreciate Wolverine's rigid quality control; the way it packages its products to meet your needs and its IOA program (Individual Order Attention) which assures you of top service right from manufacturing to final delivery.

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Wolverine Trufin is available in Canada through the Unifin Tube Company, London, Ontario.

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ELECTRICAL ENGINEER . . . experimental, theoretical, and design work on power supplies and circuit for large (megawatt d.c. and a.c. plasma generators. Knowledge of power, instrumentation, industrial and physical electronics, and an interest in gaseous discharge and arcs are desirable.

ENGINEERING PHYSICIST . . . experimental work on arc and flame processes for producing single crystals of such materials as yttrium iron garnet, refractory metal compounds. Knowledge of crystallography and background in solid state physics desirable.

PHYSICAL METALLURGIST . . . development work on arc, flame, and detonation processes for depositing coatings or forming shapes of refractory metals and ceramics. Background in gas dynamics and metallography desirable.

All positions offer attractive salaries, excellent benefits and stable employment for capable professional men who desire to work in these challenging areas at a modern laboratory of a leading industrial firm. If interested, please send resume covering education (approximate academic achievement), experience and work interests.

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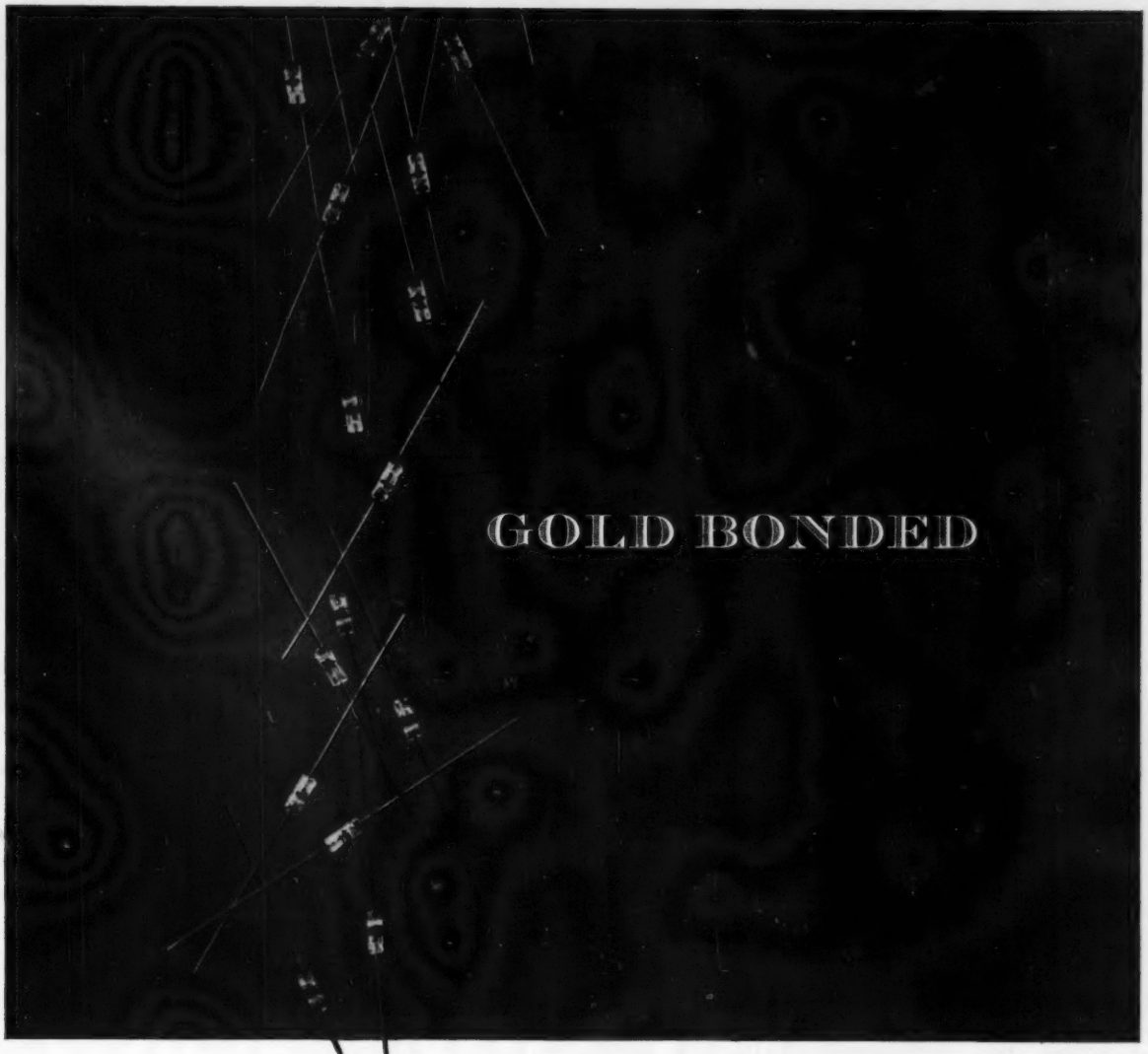

HUGHES GERMANIUM DIODES

first of all for reliability.

Typical performance levels: @ 25°C. unless otherwise stated

	Forward Current @ +1V (mA min.)	Inverse Current @ Specified Voltage (μA max.)	Maximum Inverse Voltage (Volts)
1N270	200	100 @ −50V	100
1N276	40	100 @ −50V 100 @ −10V*	60
1N277	100	250 @ −50V* 75 @ −10V*	125

*Measured @ 75°C.

For additional information write: Hughes Products, Marketing Dept.—Semiconductors, International Airport Station, Los Angeles 45, California.

Hughes gold bonded diodes exhibit fast recovery together with high forward conductance, low reverse leakage and high peak inverse voltage. They are fusion sealed in a subminiature one-piece glass envelope. This assures you complete isolation from damage or contamination.

Under varied and severe environmental and operating conditions, Hughes Gold Bonded diodes exhibit outstanding performance. You can be assured of reliable performance, since Hughes diodes exhibit the following characteristics: shock resistance... vibration resistance... thermal stability... electrical stability.

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LIGHTNING REFERENCE BIBLIOGRAPHY
1936-1949

Prepared by the AIEE Lightning and Insulator Subcommittee, this bibliography, S-37, contains 754 separate references on lightning and related topics published from January 1, 1936, to December 31, 1949, in most of the better known English, French, and German journals on electrical engineering or physics.

For easy reference, there is a Subject Section, subdivided into 18 classifications, and an Author Section, which contains a list of about 550 authors. Price: $0.70 ($0.35 to AIEE members).

Available from the Order Department, AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, 33 West 39th Street, New York, N. Y.

Industrial Notes...

Babcock & Wilcox
New York, N. Y...

A combined research and test reactor and "hot exponential" facility will provide industry with a means of determining accurately how reactor cores will behave at operating temperatures. Company spokesmen of Babcock & Wilcox, 161 E. 42nd St., New York, N. Y., said that in the past reactor behavior for these conditions has been determined by calculations based on experiments at room temperatures. Now, with this facility, reactor characteristics at high temperatures can be measured. The reactor and hot exponential facility unit is housed in a newly constructed bay of the Critical Experiment Laboratory at Lynchburg, Va.

Photographic Scientists & Engineers
Pittsburgh, Pa. . .

A new, low-intensity ultraviolet sensitometer, designed by R. F. Newell of Eastman Kodak's Film Testing Division, was described at the annual convention of the Society of Photographic Scientists and Engineers, Box 1609, Main Post Office, Rochester, N.Y. Mr. Newell said the instrument is designed to expose film to ultraviolet radiation in a series of calibrated steps. This provides faster and more uniform testing of large volumes of film and plates produced for spectrographic work in such fields as chemical analysis and metallurgy. A germicidal lamp, is the source of energy. A sector wheel turning at 1,700 revolutions per minute provides exposure of the film to ultraviolet radiation in the required series for ease in testing film sensitivity.

N. Y. Testing Laboratories, Inc.
New York, N. Y...

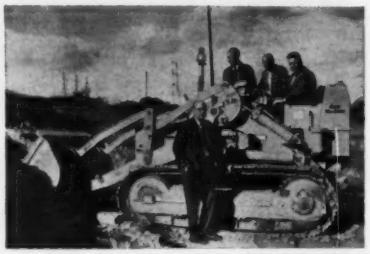
An environmental temperature altitude chamber capable of simulating altitudes up to 200,000 feet has been acquired by the New York Testing Laboratories, Inc., 47 West St., New York, N. Y. The chamber is especially designed to test components that will go into the manufacture of space vehicles and missiles. The chamber will be used in connection with an over-all reliability program instituted by Government agencies to make sure components used in space aircraft, missiles, and rockets perform satisfactorily under all possible conditions.

Federal Pacific Electric Co.
Newark, N. J. . .

T. M. Cole has been elected president of Federal Pacific Electric Company, 40 Paris St., Newark 1, N. J., and J. S. Thompson has been named honorary chairman. Mr. Cole is expected to devote most of his time to implementing future expansion plans. The company is now turning its attention to foreign markets. In September 1958, the company announced the acquisition of its Canadian subsidiary, Federal Pacific Manufacturing Co., Toronto, Ont. Further moves are expected shortly in Canada and other countries.

RT & E Corp.
Waukesha, Wis. . .

Ground has been broken for the new RT & E Corporation research and engineering laboratory to be located adjacent to the main plant at 1902 E. North,



Waukesha, Wis. Shown left to right are C. W. Shaw, executive vice president, Loren Barre, marketing manager, R. D. Nelson, president, and Edwin Link, vice president in charge of engineering.

Westinghouse Electric Corp.
Bloomfield, N. J. . .

Danger to patients from overexposure to X-rays will be reduced and brighter X-ray images made possible as the result of recent discoveries by Professor Georges Destriau, Westinghouse consultant and a member of the faculty of the University of Paris. By replacing the screen of the ordinary fluoroscope with an electroenhancement screen, brighter images can be achieved, the patient can be removed, and the image made to reappear. According to E. G. F. Arnott, director of research for the Westinghouse Lamp Division, Bloomfield, N. J., the discovery means that an image of adequate brightness can be obtained with the use of less intense radiation; if the usual level of radiation, a brighter image will result.

Zenith Radio Corp.
Chicago, Ill. . .

The entire capital stock of Central Electronics, Inc., 1247 W. Belmont, Chicago, Ill., has been purchased by Zenith Radio Corp., 6001 W. Dickens Ave., Chicago 39, Ill. Central Electronics produces high-quality single-sideband equipment for radio amateurs, and other electronic products; it will operate as a wholly owned Zenith subsidiary.

(Continued on page 34A)

why buy three?

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THE HUBBARD

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Look for this emblem. It is symbolic of the Hubbard EHD, the industry's first Single-Vent, Small-Bore Extra Heavy Duty Cutout—a single cutout that will provide positive and safe protection against all fault currents from the point of minimum fuse melting to the maximum rating of the EHD.

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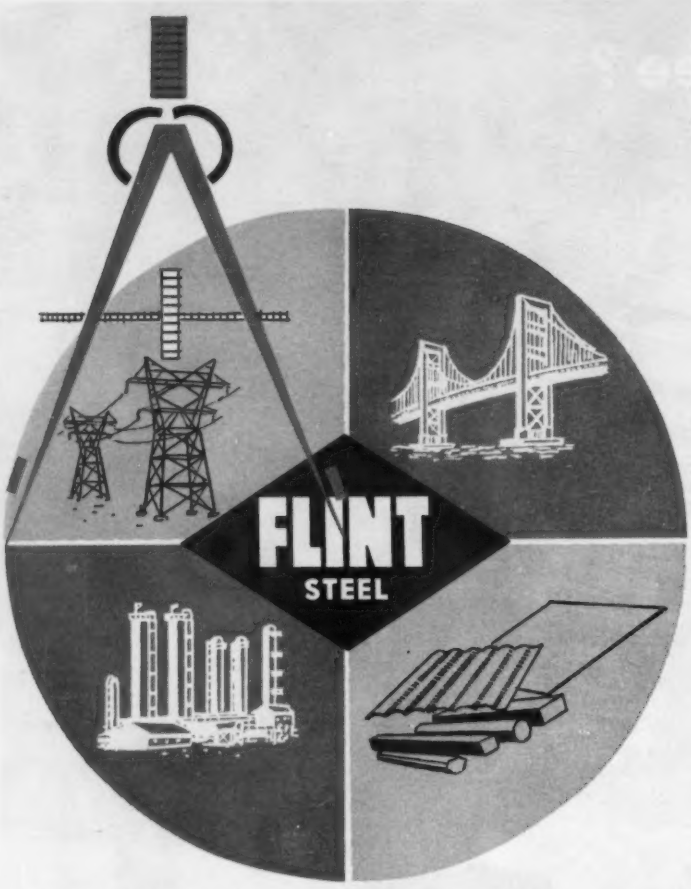

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FLINT STEEL CORPORATION

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Structural steel can now be delivered promptly and when required.

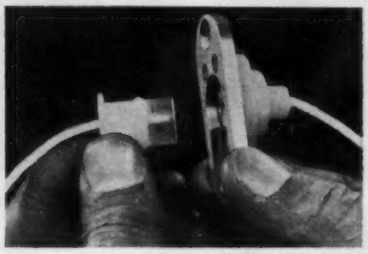
For more information circle 27 on reader service card.

Industrial Notes

(Continued from page 32A)

Alden Products Co. Brockton, Mass. . .

A motor fire connector utilized in the launching of missiles is injection molded of Plaskon nylon by Alden Products Co., Brockton, Mass., to meet stringent demands of reliability and ruggedness. The device plays an important part in the launching of a missile at it carries the electrical firing charge from the launcher to the missile ignition system. According



Courtesy Plaskon News Service

to the manufacturer, the use of injection molded Plaskon nylon *8200* provides insulation for the contacts as well as mechanical protection for the unit itself. Injection molding of the nylon around the contacts produces a seal against contaminants and moisture at the point where the wire enters the body of the connector and also provides an added measure of strain relief.

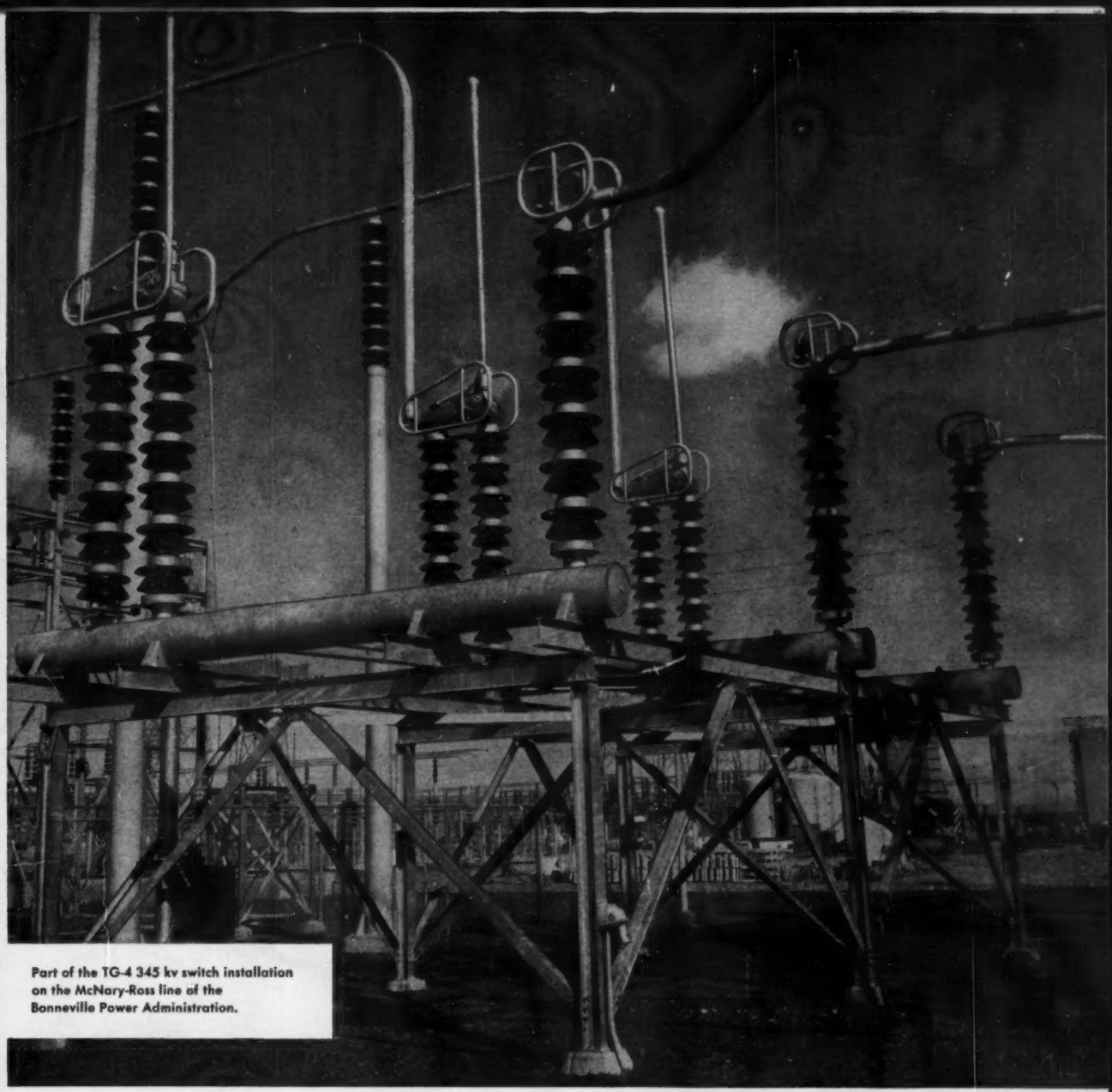
Philco Corp. Philadelphia, Pa. . .

Lightweight, mobile electronic data processors, designed to meet U. S. Army field requirements under combat conditions, will be used for combat computations, control data processing, and support data processing. A contract to design and build the first two mobile data processors has been awarded to Philco's Government and Industrial Division, 4700 Wissahickon Ave., Philadelphia 44, Pa. Official names for the data processors are Basicpac and Logicpac. Both are essentially the same, but the Logicpac will have larger core storage and greater input–output capabilities.

Electrosolids Corp. Panorama City, Calif. . .

To meet the mushrooming demands for its products, Electrosolids Corp., has moved into a specially constructed building at 13745 Saticoy, Panorama City, Calif. A feature of the new facility is the isolation of the test and development area in an air-conditioned sound-proof room.

(Continued on page 38A)



Part of the TG-4 345 kv switch installation on the McNary-Ross line of the Bonneville Power Administration.

FROM AIR SWITCHES TO COMPLETE SUBSTATIONS A DEPENDABLE SINGLE-SOURCE FOR ALL YOUR SWITCHGEAR REQUIREMENTS

Federal Pacific TG-4 air switches (illustrated above), were among the first in this country to go into service at 345 kv. Providing consistently safe, trouble-free operation, these extra-high-voltage switches demonstrate the switchgear design leadership Federal Pacific offers you.

Of advanced, simplified design, the TG-4 is available in BIL ratings from 1300 to 1800 kv, 1600 amp continuous current and 70,000 amp momentary current ratings to meet the ever-accelerating trend toward higher and higher voltages.

Whatever your needs—switchboards, low voltage metal-enclosed, medium voltage metal-clad, unit substations, power circuit breakers, power switching equipment or complete substations—you can depend upon Federal Pacific for quality switchgear. For further information write Department APR, Federal Pacific Electric Company, 50 Paris Street, Newark 1, N. J.

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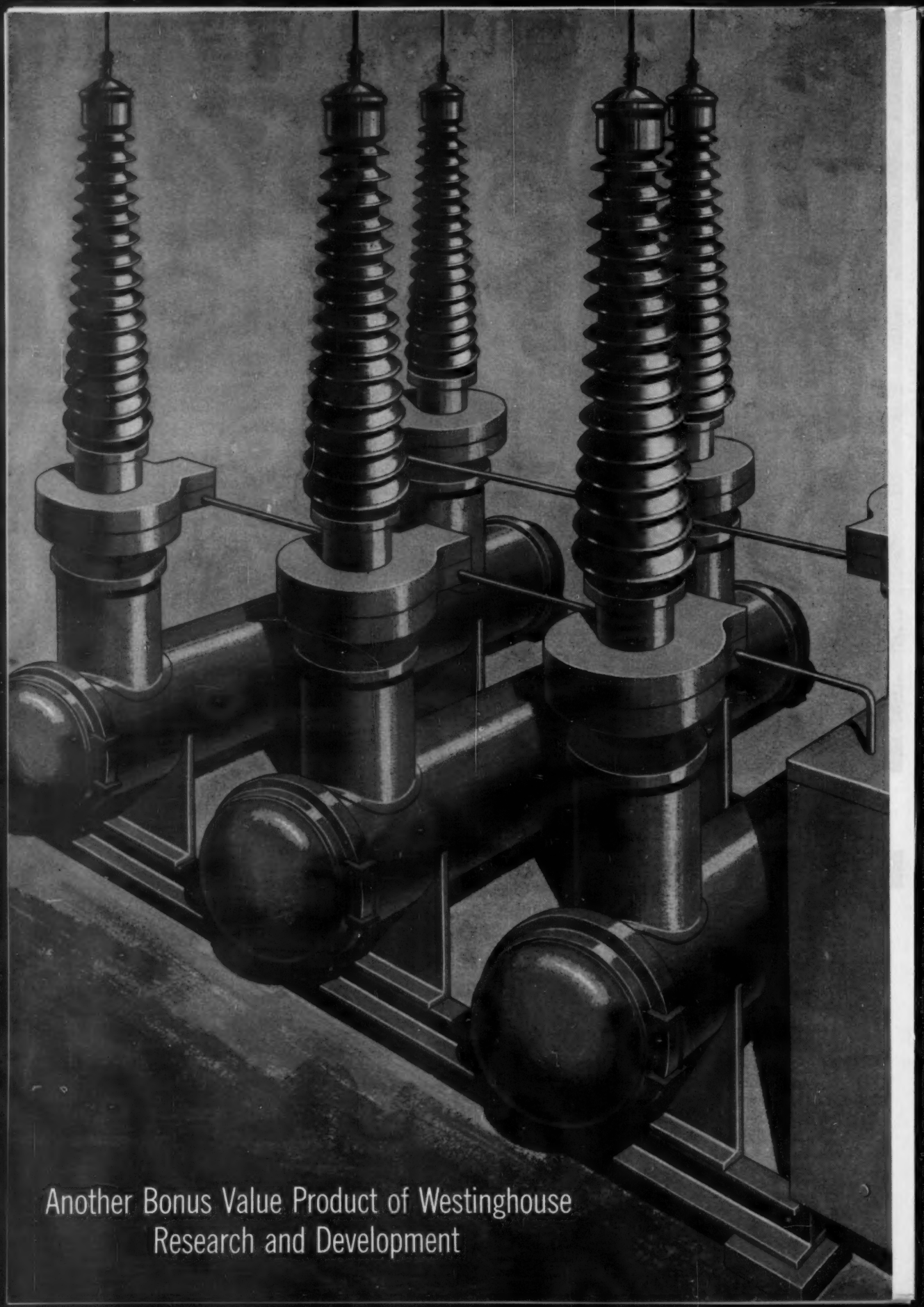
For more information circle 28 on reader service card.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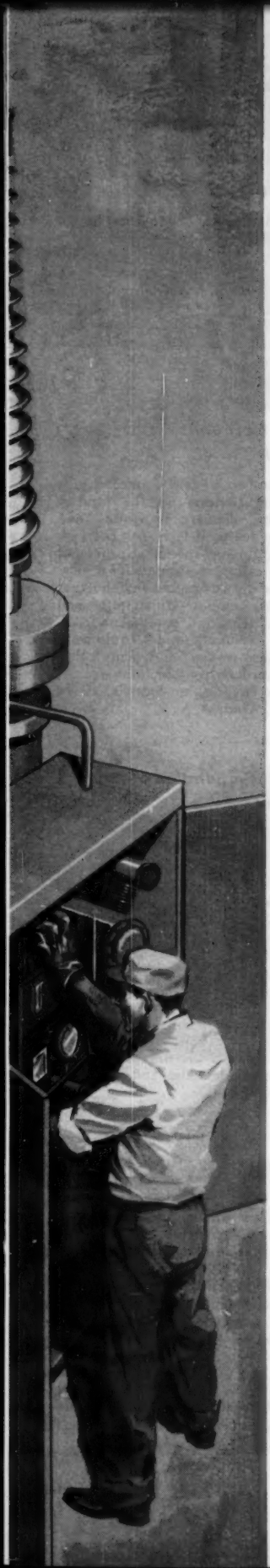
Research and Development



WESTINGHOUSE ANNOUNCES New Power Circuit Breaker Using SF_6 Gas

The Only Significant Advance in Circuit Interruption Techniques in Over 15 Years

A revolutionary 230-kv, 15 million-kva, high-capacity circuit breaker, using sulphur hexafluoride (SF_6) as the extinguishing medium, has been developed at the Westinghouse High Power Lab. This new interrupting technique will permit higher breaker ratings and much longer, more economical operating life than present designs.

This unique new horizontally mounted breaker brings the industry many radical design innovations with important savings in installation and maintenance.

Drastically slashes maintenance. This unusually stable gas does not decompose, and thus its life is not the controlling factor in time between maintenance. The interrupter assembly can be easily removed at ground level for inspection and maintenance — no scaffolding is required.

Allows simplified foundations. There is no energy transfer to foundation during interruption. Reduced size and elimination of oil has reduced weight of 230-kv gas breaker by 65 percent.

Dead tank construction provides complete safety.

Inexpensive, overlapping protection with bushing-type current transformers available on both sides of breaker.

Quiet operation. The breaker has a closed gas system, thus no discharge to atmosphere, which keeps the noise to a level comparable to the oil breaker. The closed system also conserves gas and prevents contamination.

The outstanding advances in this new breaker design are made possible because of the unusual characteristics of sulphur hexafluoride gas as an extingiushing medium:

SF_6 rapidly recovers dielectric strength because of exceptional affinity for electrons . . . assures unexcelled arc extinction.

SF_6 is extremely stable . . . thus assuring long life of the insulating and interrupting medium.

SF_6 has high dielectric strength . . . at only 10 psi, it is equivalent to oil or to compressed air at 150 psi.

SF_6 is nonflammable . . . completely safe for crowded urban substations.

SF_6 is inert, nontoxic and odorless.

This new 230-kv breaker is the first of a complete line of high-capacity SF_6 breakers. To learn how SF_6 can bring new economies to your system, call your Westinghouse sales engineer, or write Westinghouse Electric Corporation, P.O. Box 868, Pgh. 29, Pa.

J-60962

YOU CAN BE SURE...IF IT'S Westinghouse

WATCH "WESTINGHOUSE LUCILLE BALL DESI ARNAZ SHOWS" CBS TV MONDAYS

R. C. Boyd, R. E. Friedrich and B. P. Baker inspect the interrupter components of the new SF_6 breaker. A high-velocity flow of gas is directed through this formed Teflon orifice to extinguish the arc.

THOR TITAN ATLAS BOMARC POLARIS TALOS

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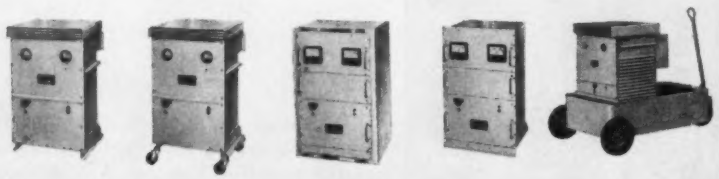


For more information circle 30 on reader service card.

Industrial Notes

(Continued from page 34A)

Epsco, Inc.
Boston, Mass. . .

The U. S. Navy has contracted Epsco, Inc., 588 Commonwealth Ave., Boston 15, Mass., to construct a data acquisition system to be used at the Navy's Underwater Sound Laboratory at New London, Conn. The system is designed to accept 20 channels of voltage information gathered from Sonar and similar underwater detection and ranging equipment.

Columbus Electronics Corp.
Yonkers, N. Y. . .

Operation of a new Semiconductor Manufacturing Division for the production of silicon rectifiers, transistors, and other semiconductor devices has been established to provide special requirement and general purpose semiconductor devices to be used in the design and manufacture of electronic computers, aircraft and automotive systems and equipment, communications systems and equipment, guided missiles, rockets, and many other civilian and military projects. Manufacturing and office facilities are located at 1010 Saw Mill Rd., Yonkers, N. Y.

Geophysics Corporation of America
Boston, Mass. . .

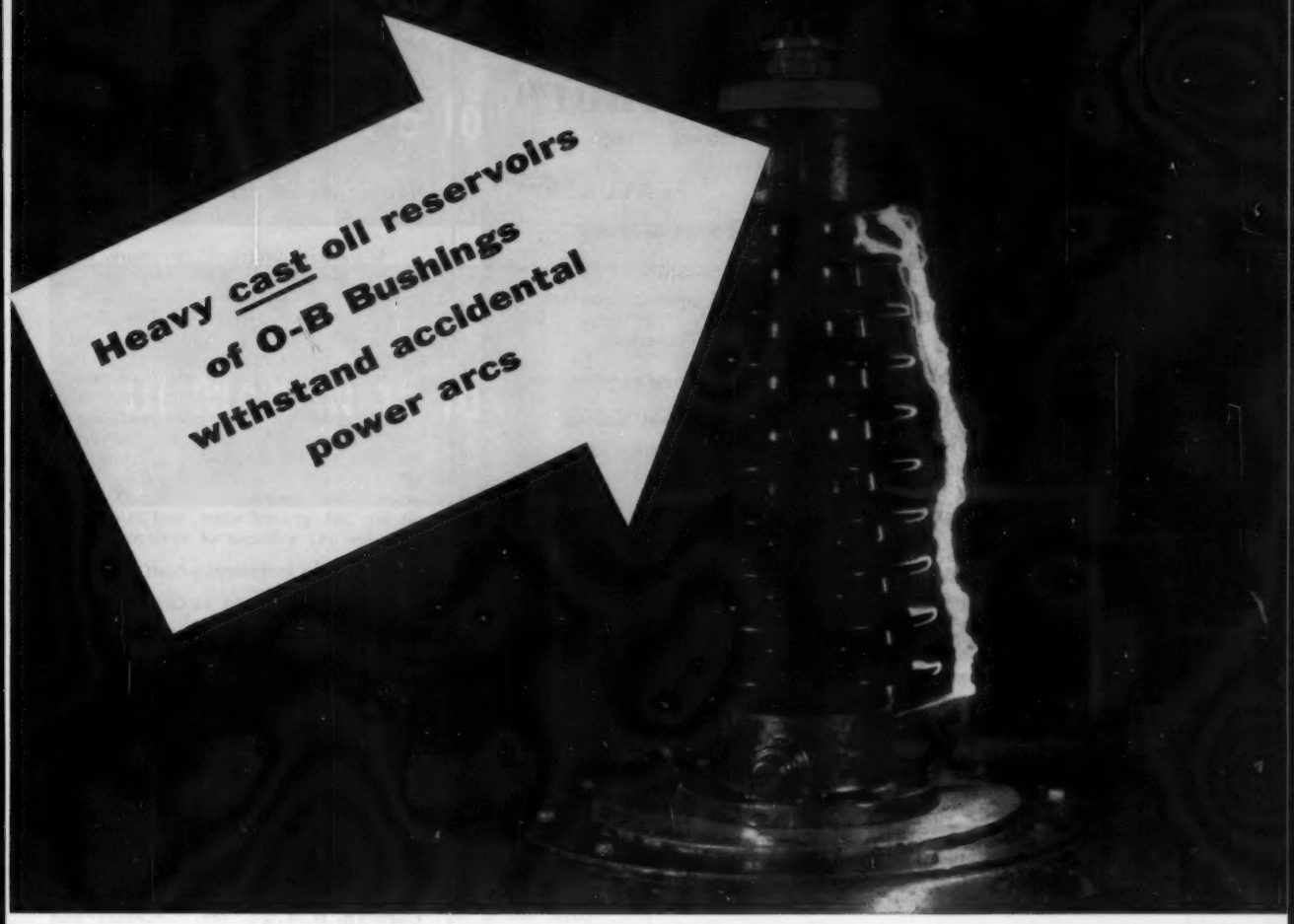
The formation of Geophysics Corporation of America has been announced by Milton Greenberg, president. Executive offices are located at 700 Commonwealth Ave., Boston, Mass. The company will provide Government and industry with advanced research and development services in the field of environmental physics, concentrating initially in radiation physics, extraterrestrial radiation, physical and chemical properties of gases, and properties of magnetic and electrical fields. Particular attention will be given to the interactions between the natural environment and man-made bodies and artificially generated changes.

High Voltage Eng. Corp.
Burlington, Mass. . .

A 6-million volt linear accelerator designed for medical therapy and research can produce a sharply defined beam of intense Xrays or be converted for high energy electron output. For radiology, the Linac has an X-ray output of 200 roentgens per minute at 100 centimeters. Converted to electron output, it will deliver up to 500 watts at energies from 2 to 7.5 mev making it a valuable tool for sterilization of tissue and bone transplants, surgical materials, and for biophysics, biological, and cancer research.

(Continued on page 40A)

Harder to poke a hole in...



Why make a bushing's oil reservoir in the form of a heavy bronze casting? Isn't it wasteful? After building bushings this way for 50 years, maybe we just can't break with tradition.

Granted, 50 years' experience has a lot to do with it. On rare occasions, the reservoir may serve a special purpose. In the event of flashover, it is one terminal of a blazing power arc. This can burn a hole in a flimsy part, and the bushing is lost. Heavy cast bronze is the best insurance against such damage we know of. The small extra cost involved is simply an investment in maximum safety and service.

One of the intangibles you buy in modern O-B condenser bushings is mature knowledge of the business. This shows-up in all kinds of ways and places. It's "the extra value in the package."

Manufacturers of transformers and circuit breakers are glad to supply the bushing of your choice, *when you express that choice.* Make a point of asking for O-B bushings. It's very well worth the slight extra attention.

OHIO BRASS COMPANY, MANSFIELD, OHIO

Ohio Brass HOLAN

PORCELAIN INSULATORS · LINE HARDWARE · CAPACITORS · LIGHTNING ARRESTERS
BUSHINGS · HOLAN TRUCK-MOUNTED POWER DEVICES AND BODIES · BRONZE VALVES

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APPLICATIONS

Electrical and Acoustical Measurements
Electrical Communication Systems (Selective Calling)
Remote Operation and Supervisory Control of Machinery and Apparatus
Electrical Computers and Telemetering Systems
Electro-Mechanical Bandpass Filters

Frahm Oscillator Controls, Type ROC, make possible the design and construction of inexpensive, precision tone generators that are small and light weight. These generators will have accurate output frequency and output voltage with very nearly sinusoidal wave shape.

They can be made with any one nominal control frequency between 20 and 1100 cps. They will control the output frequency of circuits, under specified conditions, constant within ±0.15% of the nominal control frequency.

We particularly encourage your inquiries and correspondence on special applications and problems. If you haven't explored these Frahm Oscillator Controls we'll be glad to send you complete specifications, characteristics, etc. Write for Bulletin EE.

8-704

JAMES G. BIDDLE CO.
ELECTRICAL TESTING INSTRUMENTS • SPEED MEASURING INSTRUMENTS
LABORATORY & SCIENTIFIC EQUIPMENT
1316 ARCH STREET, PHILADELPHIA 7, PA.

For more information circle 32 on reader service card.

Industrial Notes

(Continued from page 38A)

Atomics International Canoga Park, Calif. . .

The first building of a new headquarters complex at 8900 De Soto Ave., Canoga Park, Calif., is now occupied by Atomics International, a Division of North American Aviation, Inc. Location of the company's new center of operations is a 68-acre plot on the east side of De Soto Ave. between Nordhoff and Parthenia Sts. The building will house about 500 employees initially from warehousing, traffic, shops, and engineering operations.

Nuclear Metals, Inc. Concord, Mass. . .

A modern functional structure devoted to the research and development of materials for nuclear work has been dedicated by Nuclear Metals, Inc. One third of the cost of the new building is accounted for in the installation of safety equipment to safeguard employees and the community from possible hazards of working with modern metals and materials, some of which are difficult to handle. In addition to the elaborate in-plant safety devices, the company has eight property-line monitoring stations to sample air, soil, ground water, and rain and snow for any evidence of environmental changes.

Hutchinson Co. Redwood City, Calif. . .

Formation of Hutchinson Co., has been announced. The company will act as electrical engineering manufacturer's representative serving electrical utilities and electronic industrials in northern California and northern Nevada. Offices, display rooms, and warehouse space will be at 804 Bradford St., Redwood City, Calif.

Corning Glass Works Corning, N. Y. . .

An electronics plant devoted to manufacturing glass electronic components has been placed in operation at Bradford, Pa., by Corning Glass Works. Covering more than 142,000 square feet of production and office space, the plant produces glass resistors, capacitors, and other electronic parts.

G-V Controls Inc. Livingston, N. J. . .

This company has moved from East Orange, N. J., to a newly built plant at Okner Pkwy., Livingston, N. J. The new one-story plant, with both office and manufacturing areas completely air conditioned, permits the company to have all its research and development, manufacturing, engineering, and administrative activities in one building.

Use Armco's Special Electrical Steels to step up performance and cut costs

TRAN-COR A-6 for	**Audio and TV Transformers** **High Impedance Devices** **Instrument Transformers** **Servo-mechanisms** **High Frequency Generators**
DI-MAX M-15 for	**Large Motors and Generators** **Induction Regulators** **High Efficiency Motors** **TV Power Transformers** **Watt-hour Meters**

These Armco-pioneered electrical steels offer unique combinations of properties that give you both design and production advantages.

TRAN-COR® A-6 provides exceptionally high permeability at low and moderate inductions, reasonably uniform properties in all directions, low core loss and adequate ductility. It's available in coils or cut lengths, in 29 and 26 gage, with or without standard or special Armco insulations.

DI-MAX® M-15 is a low core loss grade with uniform high ductility for punched laminations of any size and shape. At high inductions its permeability is better than that of standard M-15, and its flatter, smoother surface assures a high lamination factor. Available in coils, DI-MAX M-15 has uniform gage and annealed ductile welds that facilitate punching and core assembly.

Design Data Available

Put the unusual magnetic and fabricating properties of these special Armco Electrical Steels to use in *your* products. Just fill out and mail the coupon for extensive design data that will help you use them most effectively.

Armco Steel Corporation
1419 Curtis Street, Middletown, Ohio

Send me design data on
☐ Armco TRAN-COR A-6 ☐ Armco DI-MAX M-15

Name_____

Company_____

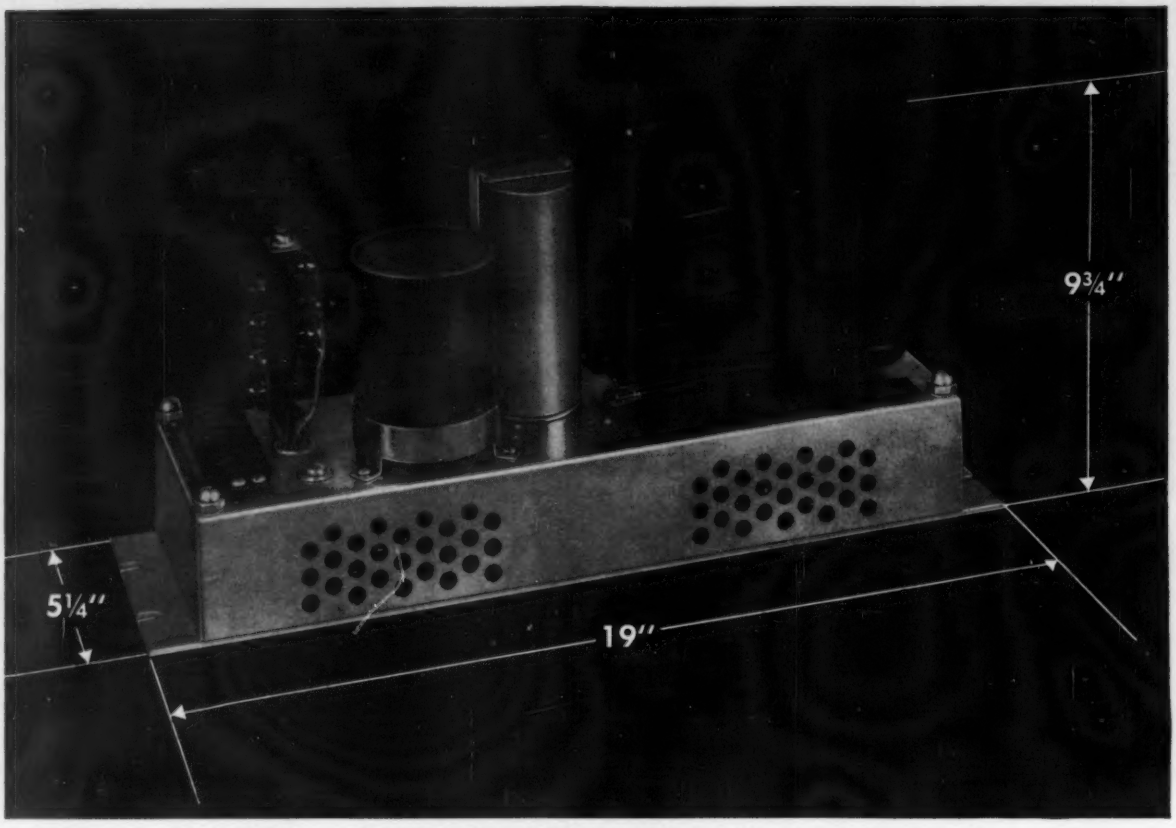
Street_____

City_____ Zone_____ State_____

ARMCO STEEL

Armco Division • Sheffield Division • The National Supply Company • Armco Drainage & Metal Products, Inc. • The Armco International Corporation • Union Wire Rope Corporation • Southwest Steel Products

For more information circle 33 on reader service card.



Sola Constant Voltage DC Power Supplies are designed for intermittent, variable, pulse or high-amperage loads.

Sola packs 6 amps of 300-watt regulated dc power into 5¼ inches of relay-rack space

Looking for a source of regulated dc power that fits into a small space? You'll probably find that the Sola Constant Voltage DC Power Supply offers what you want.

This compact unit has exceptional performance characteristics, too — it delivers current in the "ampere range," regulates within ±1% even under a ±10% variation in line voltage, has less than 1% rms ripple, and even tolerates dead shorts. It is 80% efficient and has a very low static output impedance.

How's it done? Sola managed it through a balanced assembly of three complementary components . . . a special Sola Constant Voltage Transformer is teamed up with a semiconductor rectifier and a high-capacitance filter. Electrical characteristics of the transformer maximize most of the advantages of the rectifier and filter, while virtually eliminating all their disadvantages. The resulting regulated dc power supply is simple, highly reliable, compact and moderately priced.

These benefits are exhibited by the entire line of Sola dc power supplies. Sola has designed and produced hundreds of ratings to meet requirements of equipment manufacturers. The company is set up to handle specific needs for custom-designed units in production quantities. A Sola sales engineer can supply all the facts. In addition to this custom service, Sola currently stocks six models ranging from 24 volts at six amps to 250 volts at one amp.

For complete data write for Bulletin 5B-CV-235.

Sola Electric Co., 4633 W. 16th St., Chicago 50, Ill., Bishop 2-1414 • Offices in principal cities • In Canada, Sola Electric (Canada) Ltd., 24 Canmotor Ave., Toronto 18, Ont.

SOLA

CONSTANT VOLTAGE TRANSFORMERS

REGULATED DC POWER SUPPLIES

MERCURY LAMP TRANSFORMERS

FLUORESCENT LAMP BALLASTS

A DIVISION OF BASIC PRODUCTS CORPORATION

For more information circle 34 on reader service card.

Dallas Power & Light Co. uses Lapp 4288 Clamp-Top Line Posts to carry 60 kv through the residential areas of Dallas, Texas.

60 kv Transmission with a "Low Voltage" Look

Is your residential system having growing pains? Substations near new load centers may solve your problems if you can run a subtransmission line through residential areas without consumer objection.

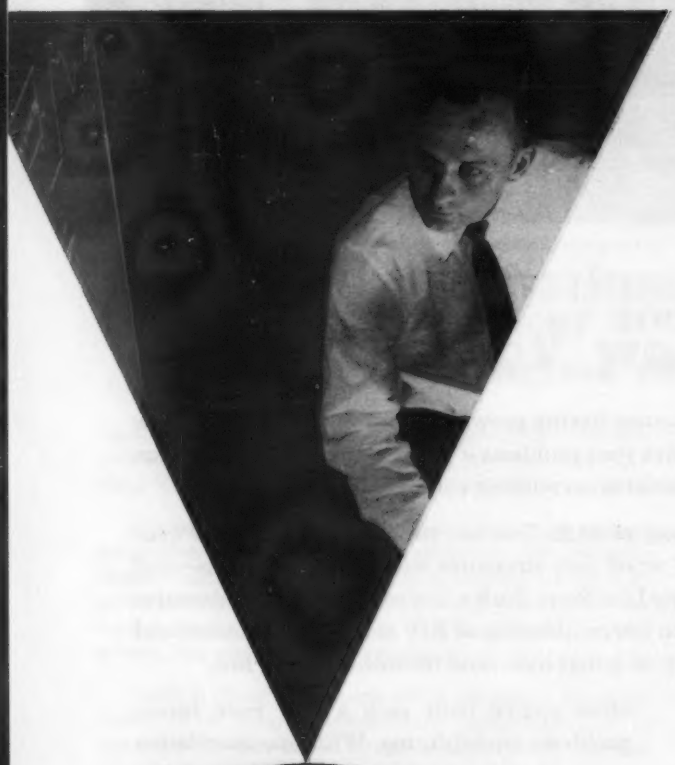
There's a proved way to do it. You can run a line at 69 kv, or even higher, on "small" wood pole structures with single crossarms—and compact, sturdy Lapp Line Posts. Such a line will have the unobtrusive look of a distribution line, will be free of RIV and TV interference, and will save you money on initial cost—and trouble-free long life.

Once you've built such a line your future problems diminish, too. With one installation —good looking, high-performance, complaint-free—it will be easier to get rights-of-way for future transmission lines. Lapp Line Posts, either with tie-wire head or clamp-top, are available in voltage ratings through 88 kv.

Lapp Insulator Co., Inc., Le Roy, N. Y.

For more information circle 35 on reader service card.

There is a creative engineering career for you at IBM



IBM Military Products offers creative engineers and scientists many challenging and unique career assignments in applying IBM's vast wealth of computer technology. Typical is the work of Engineer David R. Baldauf, who reports: "At Owego I have the opportunity to work on completely integrated B-70 bombing-radar-navigational systems. This means that my assignments have tremendous scope and versatility. For instance, I'm now evaluating several contractor proposals for a monopulse radar system, and at the same time I'm performing a study on attaching a unique radar indicator to the presently produced bombing system. I've moved rapidly at IBM, and there's still plenty of room for me to advance."

Challenging assignments now open

- **Airborne digital & analog computers**
- **Ground support equipment**
- **Inertial guidance & missile systems**
- **Information & network theory**
- **Magnetic engineering**
- **Maintainability engineering**
- **Optics**
- **Radar electronics & systems**
- **Servomechanism design & analysis**
- **Theoretical physics**
- **Transistor circuits**

QUALIFICATIONS: B.S., M.S. or Ph.D. in Electrical or Mechanical Engineering, Physics, or Mathematics, and proven ability to assume a high degree of technical responsibility in your sphere of interest.

FOR DETAILS, write, outlining your background and interest, to:

Mr. P. E. Strohm, Dept. 550B
International Business Machines Corp.
Owego, New York

IBM is a recognized leader in the rapidly expanding electronic systems field. Its products are used for both commercial and military applications. Continuous growth affords excellent advancement opportunities. The "small-group" approach assures recognition of individual merit. IBM is outstanding in the area of employee benefits, and salaries are commensurate with your abilities and experience. Owego, located in rolling New York State countryside, in the Binghamton-Triple City area, provides an excellent environment for gracious, relaxed living.

IBM® **MILITARY PRODUCTS**

When you buy Motor Starters—

YOU PAY FOR OVERLOAD PROTECTION

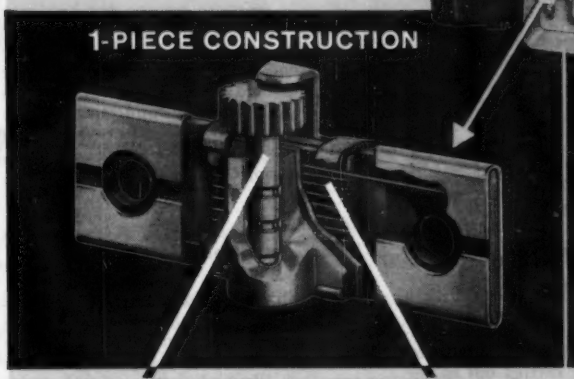
Only ONE-PIECE Overload Relays give 100% Protection • Only with ONE-PIECE construction can you *know* you've installed the heater correctly. Only with ONE-PIECE construction can you *know* the heater is exactly centered, or properly positioned, so that it performs according to its rating. Only with ONE-PIECE construction can you *know* your motors have full protection.

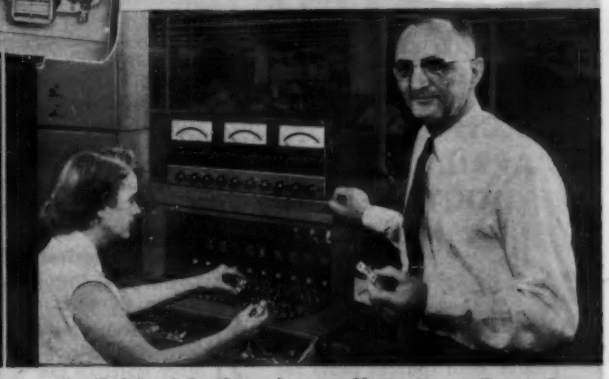
Only Square D has ONE-PIECE Construction • ONE-PIECE construction *eliminates* any possibility of heater misalignment. Square D melting alloy thermal overload relays can be installed only one way. They are tamper-proof. They are factory-assembled, are *individually* calibrated and tested. Repeated tripping will not affect accuracy

Insist on Square D melting alloy thermal overload relays

Write for Bulletin SM-275 for the complete story on Square D starters with ONE-PIECE thermal overload relays. Address Square D Company, 4041 N. Richards St., Milwaukee 12, Wisconsin.

...BE SURE YOU GET IT!





Heat-responsive element (solder pot) provides accurate response to overload, yet prevents nuisance tripping.

Heat-producing element is an integral part of overload unit. It's permanently joined to solder pot, can't become misaligned.

Individual factory inspection of every Square D melting alloy thermal overload relay means performance you can trust. Each unit is calibrated and thoroughly tested to make sure it will perform according to its rating.

EC&M HEAVY INDUSTRY ELECTRICAL EQUIPMENT...NOW A PART OF THE SQUARE D LINE

SQUARE D COMPANY

For more information circle 36 on reader service card.

SERVOMECHANISMS

Outstanding opportunity for design specialist to head group of servomechanism system design in missile tracking program.

Know theory of complex variables, operational calculus, analytical methods of network synthesis and experience in any of the following:

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New York 18, N. Y.

Print your name and address upon mailing wrapper. Twenty-five cent refund plus postage will be paid for copies returned.

Trade Literature...

D-c Power Supplies Booklet . . .

An illustrated booklet giving specifications and applications of d-c power supplies is available from **Dressen-Barnes Corporaton, 250 N. Vinedo Ave., Pasadena, Calif.**

Compressor Bulletin . . .

An 8-page bulletin covering heavy-duty low-pressure compressors has recently been published with specifications on three models ranging from 756 to 7,392 cubic feet per minute and a detailed sectional drawing. Ask for Bulletin *A-95*. **Joy Manufacturing Company, Henry W. Oliver Bldg., Pittsburgh 22, Pa.**

Short Form Instrumentation Catalog . . .

A 4-page catalog briefly describes the Eldorado electronics accelerator current integrator, Universal photomultiplier photometer, Milli-microsecond time-to-pulse-height converter, Multi-channel pulse height analyzer, Non-overloading linear amplifier, and Milli-microsecond time measuring system. Features, specifications, and price are noted. **Eldorado Electronics, 2821 Tenth St., Berkeley, Calif.**

Industrial Burner and Firing System Folders . . .

The AirRing industrial burners, described in folder No. *5807*, with built-in fuel and air systems are available for gas, oil, or dual fuel; natural or induced draft; Scotch or any other type of boiler. The industrial packaged forced-draft firing systems for dual-fuel or single-fuel firing of high or low pressure natural, LP, or manufactured gas, or any grade of oil from No. 2 to No. 6 in Scotch marine, steel firebox, water tube, or cast iron boilers, are described in folder No. *5843*. **Iron Fireman Manufacturing Co., 3170 W. 106th St., Cleveland 11, Ohio.**

Spectrochemical Laboratory Testing Facilities Booklet . . .

Extremely rapid and accurate quantitative analysis of ores, metals, and many other materials can be carried out in the Spectrochemical laboratory which is supplemented by a complete wet chemistry laboratory and extensive physical testing facilities, providing an entire analytical service. **Bowser-Morner Testing Laboratories, Inc., 141 Bruen St. at Scott, P. O. Box 51, Dayton 1, Ohio.**

Photography Cell Shutter . . .

A Kerr cell shutter for photography at exposures down to 0.01 of a microsecond is described with charts, drawings, and photographs in a 4-page brochure by **Avco Research and Advanced Development Division, 201 Lowell St., Wilmington, Mass.**

Coatings Bulletins . . .

A 12-page brochure describing Ecco-coat surface coatings is now available from **Emerson & Cuming, Inc., 869 Washington St., Canton, Mass.**

Digital Demand Recorder Catalog . . .

This impulse counting and recording device, described in a 16-page catalog, was originally developed to help automate electric utility customer billing and to record data for load survey studies; it is now proving extremely useful for other applications such as production control, traffic counting, and atomic energy work. **Fischer & Porter Co., 828 Jacksonville Rd., Hatboro, Pa.**

Molding Press Catalog . . .

A catalog on hydraulic presses and preformers for the thermoplastic molding industry decribes the complete line of Logan preformers available in 30, 50, 70, and 125 tons capacity. **Logan Hydraulics, Inc., 4901 W. Lawrence Ave., Chicago 30, Ill.**

Weighing Systems Catalog . . .

Bulletin 582, covering the Way-Pac hydraulic weighing systems, has been prepared to facilitate the application of these systems to weighing jobs and to price the installation before ordering. The brochure is sectionalized to provide ready access to both engineering and application data. A price list of component parts is an integral part of the catalog. **The A. H. Emery Co., New Canaan, Conn.**

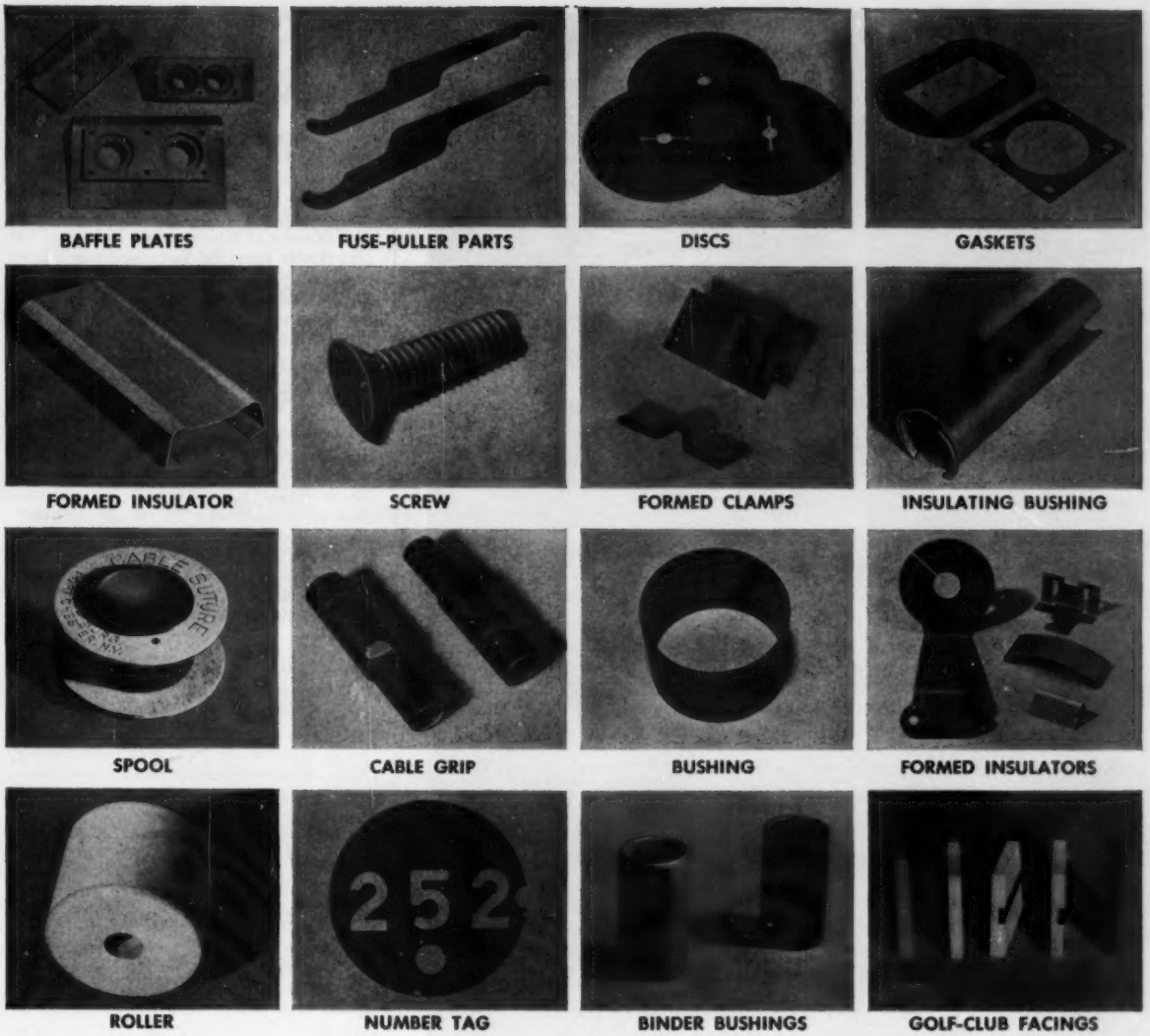
Folder on Two-Component Alternator . . .

A 4-page illustrated folder, details a line of alternators which features silicon rectifiers in lieu of standard selenium rectifiers. These alternators provide infinite operating life and vastly reduced maintenance. **The Leece-Neville Co., 1374 E. 51st St., Cleveland 3, Ohio.**

"Kelvin Scale" . . .

This news sheet of current information on cryogenics and related subjects, will be published periodically. Copies may be obtained by writing The Editor, **Kelvin Scale, Arthur D. Little, Inc., 20 Acorn Pk., Cambridge, Mass.**

(Continued on page 48A)



FIBRE–the low-cost insulation of 1001 uses

Look what Diamond Vulcanized Fibre can do for you! And look what *you* or CDF can do with *it!*

If you can keep high-quality fibre clear of its worst enemy—moisture—you have the best economical insulating material you'd ever want for high arc-resistance, non-tracking, and long-time dielectric strength.

UNIQUE PROPERTIES • The high tensile, flexural, and impact strengths, the easy workability (ideal for screw machines), the Rockwell hardness (to R80), the light weight (half that of aluminum), the low cost, and the excellent electrical characteristics (arc-resistance up to 150 sec.) of CDF Fibre make it a highly attractive basic insulation for cost-conscious designers and purchasing men. Put these properties to work in your product.

FABRICATION FACILITIES • CDF has excellent and extensive facilities and know-how for turning out finished Diamond Vulcanized Fibre parts—better and more economically than you can do it yourself. We meet *your* specifications and *your* production schedules, and save you time and money in the bargain.

Send us your print or your problem, and we'll return technical literature. For the phone number of the CDF sales engineer nearest you, see Sweet's, Electronics Buyers' Guide, and other directories.

CDF makes Di-Clad printed-circuit laminates, Diamond Vulcanized Fibre, CDF products of Teflon, flexible insulating tapes, Dilecto laminated plastics, Celoron molded products, Micabond mica products, Spiral Tubing, Vulcoid.

CDF **CONTINENTAL-DIAMOND FIBRE**

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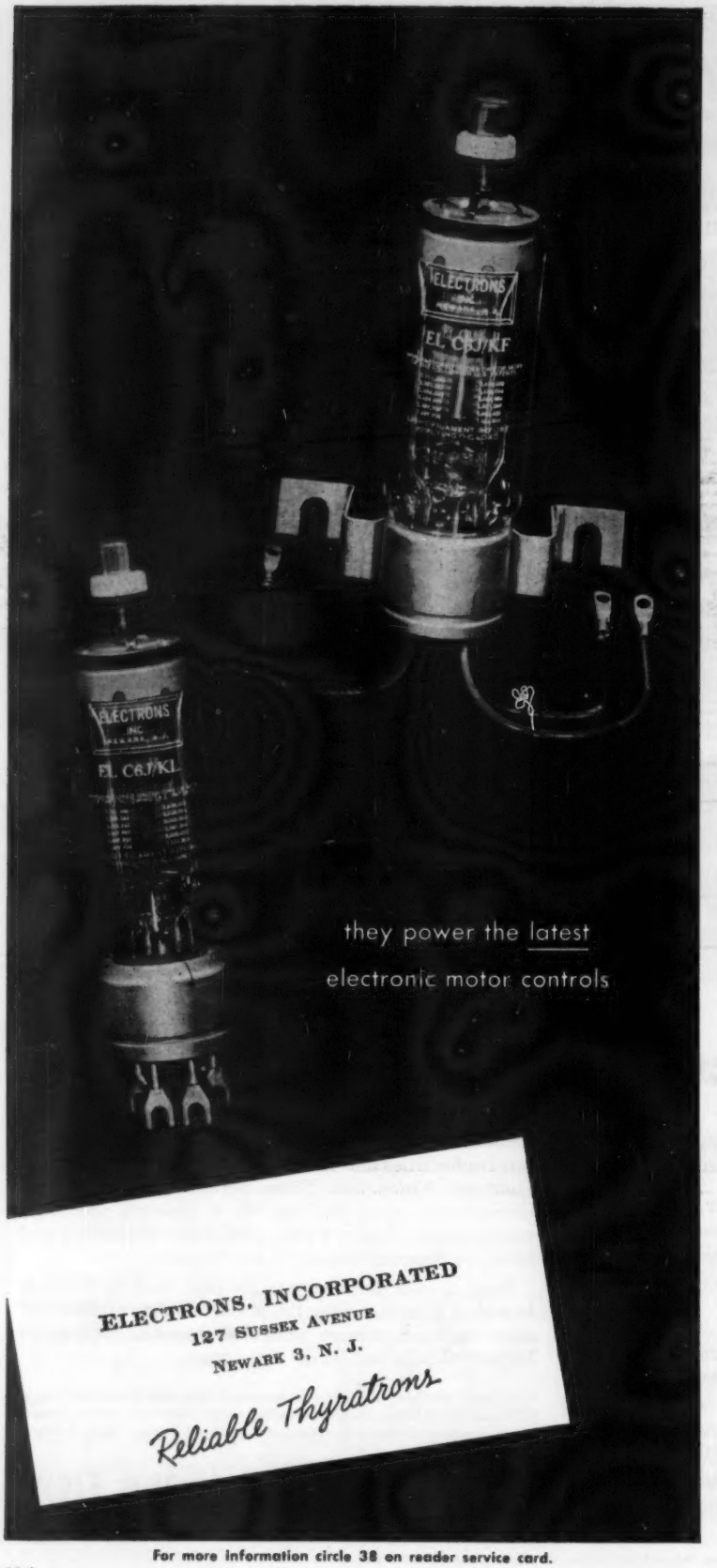
For more information circle 37 on reader service card.



For more information circle 38 on reader service card.

Trade Literature

(Continued from page 46A)

Light Controls Catalog . . .

A catalog to introduce larger capacity models of Luxtrol light controls discusses the correct use of controlled lighting in all rooms of the home, as well as in commercial applications. Additional sections are devoted to where to use light control, descriptive data, the three new types, how to install, and how to wire for incandescent and fluorescent. Bulletin *L758W*, may be obtained from **The Superior Electric Co., 83 Laurel St., Bristol, Conn.**

Ceramatemp Bulletin . . .

Ceramatemp, a ready-to-use, flexible, ceramic-type insulated wire rated for continuous operation at 1,000 F, is described in an 8-page bulletin containing information on the product, application, and handling characteristics; charts; and graphs pointing up mechanical and electrical properties. Write to Director of Technical Service, **Hitemp Wires, Inc., 1200 Shames Dr., Westbury, N. Y.**

Radio Interference Meters Bulletins . . .

Five 4-page bulletins giving specifications, military approval data, and applications of radio interference and field intensity measuring equipments covering a frequency range of 30 cps to 1,000 mc are available. **Stoddart Aircraft Radio Co., Inc., 6644 Santa Monica Blvd., Hollywood 38, Calif.**

Magnetic Circuits Publication . . .

A detailed discussion of magnetic circuits especially suited for tractive applications is featured in the latest issue of Applied Magnetics, an Indiana Steel Products Co. publication going to design engineers and other technical people interested in magnetics. Copies may be obtained free of charge by writing to Applied Magnetics, **The Indiana Steel Products Co., Valparaiso, Ind.**

Low-Priced Vibrating Capacitor . . .

A lower priced vibrating capacitor, *VC-1006/500*, permits economical use of the capacitance modulation principle in applications less exacting than those for which the *VC-713/500* was designed. In appearance, the *VC-1006/500* is identical to the *VC-713/500* except that ceramic insulation is used in place of the considerably more expensive fused quartz, resulting in a minimum insulation resistance of 10^{12} ohms. Further cost reduction has been achieved by relaxing the contact potential and drift specifications to 30 millivolts maximum and ± 2 millivolts per day respectively. Unit *VC-1006/500* is described on the back page of a 4-page vibrating capacitor catalog published by **Stevens-Arnold, Inc., 22 Elkins St., South Boston, Mass.**

Wallace, if you'd read the Roebling Roeclamp® book this never would have happened!
ROECLAMPS
WITH ASSOCIATED CABLES
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Free! The most electrifying news a utility company can read is contained in this new book about Roebling Roeclamps with Associated Cables. It tells all about the remarkable new aerial suspension clamps that give you a 5kv, 8kv, or 15kv system costing 60% less than self-supporting cables...a system that installs in a breeze, minimizes tree problems, carries more current, looks great, and which is virtually "storm-proof"! There's absolutely nothing like Roeclamps with Associated Cables...and if you distribute power, you need this book! No cost, no obligation—and the savings are all yours! For your copy, write today to Electrical Wire Division, John A. Roebling's Sons Corporation, Trenton 2, New Jersey.

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For more information circle 39 on reader service card.

AIEE STANDARDS

Standards on electrical machinery and apparatus chiefly devoted to defining terms, conditions, and limits which characterize behavior, with special reference acceptance tests.

A discount of 50% is allowed to Institute members except as noted. College and bona fide public reference libraries are allowed (except in special cases with † below) a discount of 50% for nonmember prices; dealers and subscription agencies 20%.

1	General Principles Upon Which Temperature Limits are Based in the Rating of Electric Equipment (June 1957)	$0.80
1A	General Principles for Rating of Electric Apparatus for Short-Time Intermittent or Varying Duty (9-1941) (Proposed supplement to No. 1)	—
1B	Guiding Principles for Specification of Service Conditions in Electrical Standards (May 1944)	.40
1D	Guide for the Preparation of Test Procedures for the Thermal Evaluation of Electrical Insulating Materials (June 1957)	—
1E	Guide for the Preparation of Test Procedures for the Thermal Evaluation of Insulation Systems for Electric Equipment (June 1957)	—
3	Guiding Principles for Selection of Reference Values for Electrical Standards (Oct. 1943)	.60
*4	Measurement of Voltage in Dielectric Tests (Sept. 1953) (ASA C68.1)	.80
*11	Rotating Electric Machinery Forming a Part of the Power Equipment on Electrically-Propelled Railway Cars, Locomotives, and Coaches (Trolley and Prime Mover) (Oct. 1957) (ASA C35.1)	.60
*16	Electric Control Apparatus for Land Transportation Vehicles (Oct. 1955) (ASA C48.1)	.60
*17†	Mathematical Symbols (Jan. 1928) (ASA Z10†)	.40
*18	Capacitor Units (Dec. 1951) (ASA C55.1)	.40
22	Air Switches, Insulator Units and Bus Supports (July 1952)	.80
25	Fuses Above 600 Volts (Feb. 1958)	.80
*28	Lightning Arresters for A-C Power Circuits (Jan. 1957) (ASA C62.1)	.60
*29	Wet Tests (July 1943) (ASA C77.1)	.40
31	Outdoor Coupling Capacitors and Capacitance Potential Devices (Jan. 1944)	.60
32	Neutral Grounding Devices (May 1947)	.80
43	Recommended Practice for Testing Insulation Resistance of Rotating Machinery (April 1950)	.60
45	Recommended Practice for Electric Installations on Shipboard (Dec. 1958)	3.50
48	Potheads (Jan. 1948)	.60
49	Roof, Floor, and Wall Bushings (Jan. 1948)	.60
50	Automatic Circuit Reclosers for A-C Distribution Systems (Jan. 1953)	.60
51	Guiding Principles for Dielectric Tests (6-55)	.60
54	Standard, Test Code, and Recommended Practice for Induction and Dielectric Heating Equipment (Sept. 1955)	.80
55	Guide for Temperature Correlation in the Connection of Insulated Wire & Cables to Electric Equipment (Jan. 1953)	.60
56	Guide for Insulation Maintenance for Large A-C Rotating Machinery (Feb. 1958)	.60
62	Guide for Making Dielectric Measurements in the Field (Apr. 1958)	1.00
74	Test Code for Industrial Control (600 Volts or Less) (Feb. 1958)	.80
425	Test Code for Transistors (Aug. 1957)	1.20
501	Test Code for Direct-Current Machines (7-57)	.60
502	Test Procedure for Single-Phase Induction Motors (Mar. 1958)	.60
503	Test Code for Synchronous Machines (June 1945)	1.40
510	Test Procedure for Evaluation of Systems of Insulating Materials for Random-Wound Electric Machinery (Nov. 1956)	.80
550	Master Test Code for Resistance Measurement (May 1949)	.80
551	Master Test Code for Temperature Measurement (Aug. 1950)	.80
552	Master Test Code for Electrical Measurements in Power Circuits (Nov. 1955)	1.20
600	Specification for Speed Governing of Steam Turbines for Generators (500 kw and Up) (5-49)	.60
{601} {602}	Preferred Standards and Standard Specification Data for Generators for Large 3,600-rpm, 3-Phase, 60-Cycle Condensing Steam Turbine Generators (Jan. 1953)	.60
605	Specification for Speed-Governing of Hydraulic Turbines for Driving Generators (Sept. 1950)	.60
700	Aircraft D-C Apparatus Voltage Ratings (Oct. 1953)	.40
800	Test Code for Direct-Current Aircraft Machines (Jan. 1953)	.80
801	Test Code for Aircraft Circuit Interrupting Devices (July 1954)	.40
**950	Recommended Practice for Measurement of Field Intensity Above 300 Megacycles from Radio-Frequency Industrial, Scientific, and Medical Equipments (Apr. 1952)	.80
**951	Recommended Practice for Minimization of Interference from Radio-Frequency Heating Equipment (May 1950)	.80
**952	Electric Power Distribution for Industrial Plants (Oct. 1956)	3.50
**953	Grounding of Industrial Power Systems (10-56)	1.20
C8.1	Definitions and General Standards for Wire and Cable (Dec. 1944/Oct. 1953) (AIEE 30)	.40
C8.18	Specifications for Weather-Resistant (weatherproof) Wire and Cable (URC Type) (Jan. 1948)	.60
C8.19	Weather-Resistant Saturants & Finishes for Aerial Rubber-Insulated Wire & Cable (Nov. 1939)	.40
C34.1	Pool Cathode Mercury-Arc Power Converters (Jan. 1949)	1.20
C37.1	Relays Associated with Electric Power Apparatus (Mar. 1950)	.60
C37.2	Automatic Station Control, Supervisory & Associated Telemetering Equipment (Oct. 1956)	1.30
C37.4	Alternating-Current Power Circuit Breakers (Dec. 1953)	.60
C37.5	Methods for Determining the Rms Value of a Sinusoidal Current Wave and a Normal Frequency Recovery Voltage & for Simplified Calculation of Fault Current (Dec. 1953)	.60
C37.6	Schedules of Preferred Ratings for Power Circuit Breakers (Sept. 1957)	.40
C37.7	Interrupting Rating Factors for Reclosing Service (Aug. 1952)	.30
C37.8	Rated Control Voltages and Their Ranges (8-52)	.30
C37.9	Test Code for Power Circuit Breakers (Dec. 1953)	.60
C37.11	Power Circuit Breaker Control (Sept. 1957)	.80
C37.12	Guide Specifications for A-C Power Circuit Breakers (Aug. 1952)	.60
C37.13	Low-Voltage Air Circuit Breakers (including Application Guide) (Aug. 1954)	.80
C37.14	Test Code for Low-Voltage Air Circuit Breakers (Aug. 1954)	.50
C37.15	Rated Control Voltages & Their Ranges for Low-Voltage Air Circuit Breakers (Aug. 1954)	.30
C37.16	Schedule of Preferred Ratings for Alternating- and Direct-Current Low-Voltage Air Circuit Breakers (Aug. 1958)	.30
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1E Guide for the Preparation of Test Procedures for the Thermal Evaluation of Insulation Systems for Electric Equipment (June 1957)
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52 Application Guide for Grounding of Instrument Transformer Secondary Circuits and Cases (March 1951)
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64 Guide for Maintenance of Insulating Oil (November 1956)
65 Test Procedure for Thermal Evaluation of Ventilated Dry-Type Power and Distribution Transformers (November 1958)
66 Guide for Determination of Short-Circuit Characteristics of Direct-Current Machinery (July 1957)
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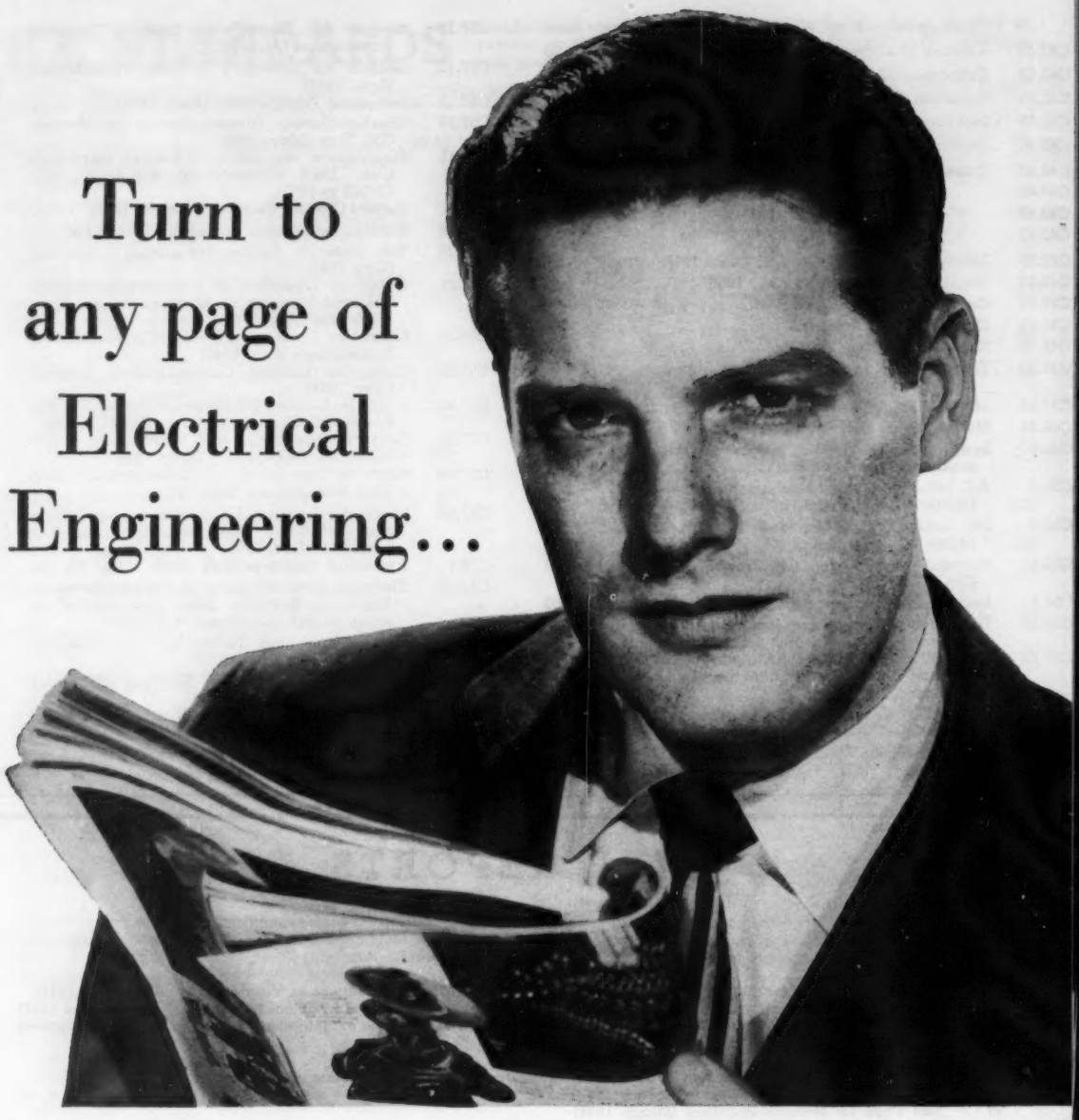

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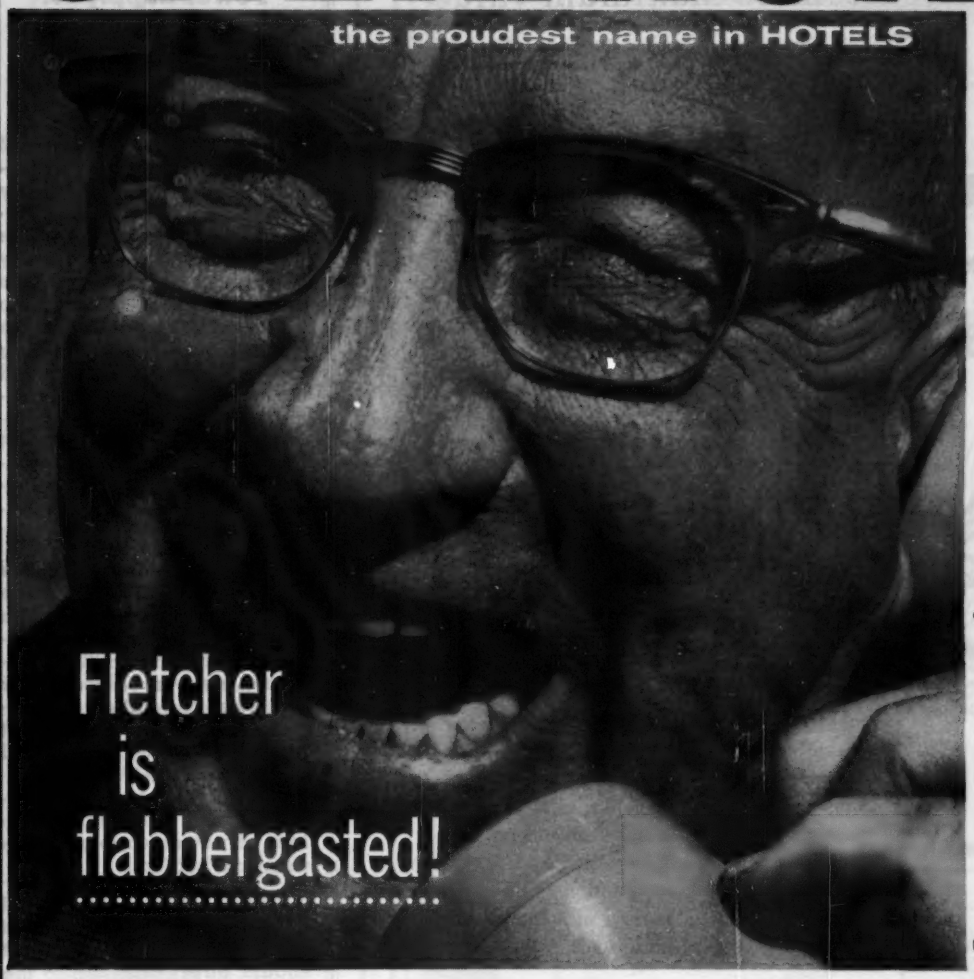

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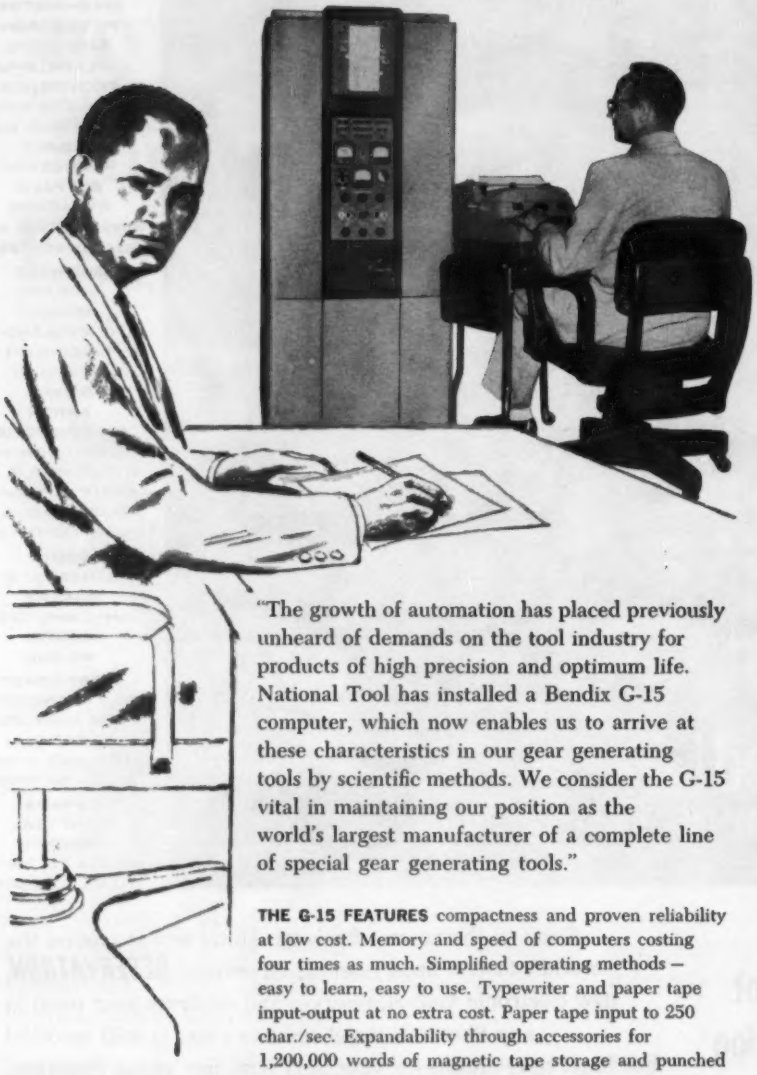

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Power Supply for Resistance Welding Machines
(April 1952)

AIEE Special Publication S-45 is a report of the AIEE Subcommittee on Power Supply for Resistance Welding Machines. Recognizing that the installation and use of any resistance welding process vitally concerns not only the industrialist requiring the process but also the welding machine manufacturer and the utility supplying the electric power as well, the committee has in this report brought together much pertinent data from the knowledge, literature, and experience in all these fields.

This publication supersedes the AIEE reports of the same title presented in 1940-1. The new work is required by developments in welding machines, new processes, better analysis of certain phenomena (such as measurement of instantaneous loads, and interference between welders), and a clearer understanding of the whole problem of power supply for resistance welders.

This report is not intended to be a complete solution of all welding problems, but should direct attention to the special electrical features involved so that a full analysis developed for a welding project can be readily understood and utilized by manager, master mechanic, and electrical engineer.

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THERMAL EVALUATION OF INSULATING MATERIALS

(June 1954)

At the 1954 Winter General Meeting the Subcommittee on Dielectrics and its Working Group sponsored three sessions of papers covering various phases of the problem of evaluating insulating materials. Since these papers review much of the recently developed information on this subject, it was decided to reprint them in this form. As test methods on the thermal evaluation of insulating materials become available, more and more data on thermal stability of both the newer and the older materials should develop, and eventually make possible the rational revision of AIEE Standard Number 1 on a sound basis.

The 72-page printed publication contains 16 papers and discussions, presented at the 1954 AIEE Winter General Meeting.

Publication S-61 is available at the price of $1.50 to members and nonmembers. Send orders to:

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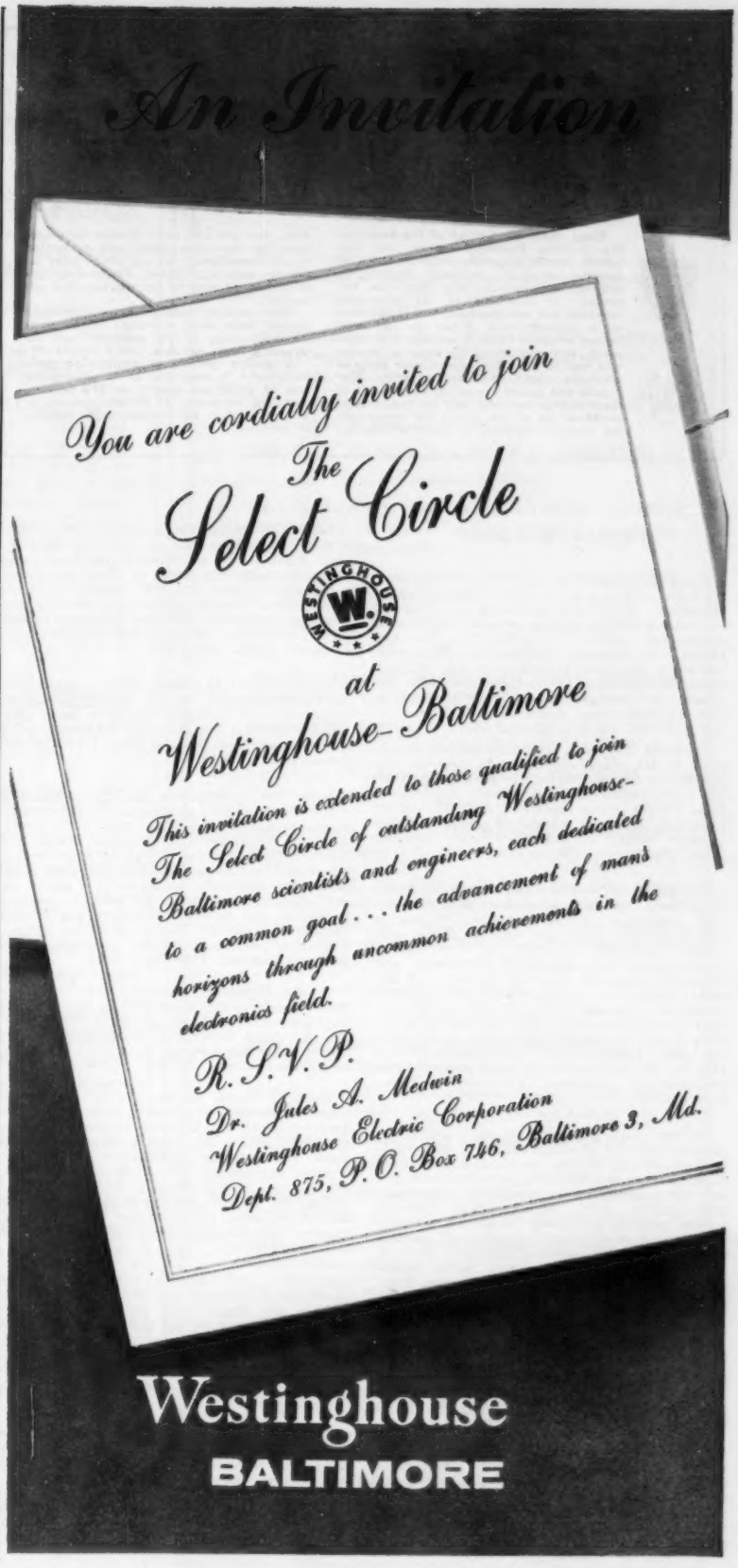
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Electrical Engineer, graduate, with a minimum of five years' experience in industry; experience in rotating machinery design, especially 400 cycle, commercial and military application. Some control system experience desired. Product is aircraft AC small motors, all phases and frequencies. Salary, $7000-$8000 a year. Location, Ohio. W-6732.

Director of experimental physics section, Ph.D. in physics. training in atomic physics, solid state, quantum electro-dynamics. Microwave and/or infrared experience desired. Duties will include technical direction of experimental physics group now engaged in government and industrial sponsored programs in basic and applied research in government and industrial sponsored programs in basic and applied research in microwave and infrared solid state devices. Salary, $14,000-$18,000 a year; profit sharing plan. Company will pay placement fee. Must be cleared for secret or have no known impediment to clearance. Location, Midwest. W-6740-C.

Assistant Sales Manager, for an electrical insulation division; graduate electrical or equivalent experience relating to electric insulation. Experience in the following capacities with meter, transformer, coil or electronic components manufacturer: Sales engineer, field technical service, general equipment design or material and process development. Duties will involve field technical sales, working through a national manufacturers agent organization. Salary, $6500-$10,000 a year, plus profit sharing bonus. Traveling. Headquarters, western New York State. W-6756.

Technical Publicity Man for an industrial advertising agency; graduate electrical, with proven skill in preparing feature articles on complex technical subjects. Salary good, profit sharing, fringe benefits, excellent future. Location, eastern Pennsylvania. W-6765.

Research and Development Engineers, graduates in electrical engineering, with communications or electronics major, or physics. Experience in applied research and/or development of electronically actuated instruments; several years' of research or development with some forms of electro-mechanical device is necessary. Salaries open. Location, Connecticut. W-6775.

Senior Production Engineer, B.S.E.E., with a minimum of three years at a senior level design manufacture of military electronic telecommunications equipment or allied equipment, using digital, pulse and MV circuitry including transistorized versions. Knowledge of MIL components, equipment packaging including printed circuit techniques. Salary, $10,000-$13,000 a year. Location, lower Connecticut. W-6785.

Geophysicists. (a) Geophysicist or Physicist for theoretical research in all phases of mining geophysics, (b) Geophysicist with some electronic capability for electrical field exploration and interpretation. Salaries open. Headquarters, Connecticut. W-6788.

Supervisor, Automation and Instrumentation Applications, degree in mechanical or electrical engineering, with five years' experience in control and instrument applications. Duties will entail the analysis and design of servo mechanisms and control applications for high speed production machinery in the fields of metal, paper, glass and plastics as used in making packaging and canning containers and flexible packaging materials. These machines require hydraulic, pneumatic, and/or electronic control devices. Location, Illinois. W-6803.

Project Engineer, graduate electrical, with three or more years' experience in electronics or electro-mechanical work. Practical manufacturing experience important. Salary, $7200-$10,000 a year. Company will pay placement fee. Location, Rhode Island. W-6807.

Senior Research Engineers with five to ten years' experience. (1) Radar, Countermeasures, Ferret Systems. (2) Infrared Systems. (3) Pulse Circuitry, Analog and Digital computer components (4) Airborne Stabilization Systems. (5) Nuclear Engineering, Transistor Circuit Design. (6) Nuclear Instrumentation. (7) Telemetering Systems for Missiles and Satellites. (8) Antennas and Propagation. (9) Pulse and Video Circuits. Salaries high. Location, New York Metropolitan area. W-6811.

Physicists. (a) Physicist (optical) with five years' optical system design and analysis. Experience in lens bench work. (b) Junior Physicist experienced in setting up and operating special electronic optical equipment. (c) Physicist (Crystallographer) with several years' experience with piezo electric transducers for high frequency applications. Salary high. Location, Long Island, New York. W-6812.

Electrical Engineers. (a) Electrical Engineer, to take complete charge of developing new line of motors and servos for use in missiles and similar instruments. Salary, to $15,000 a year. (b) Electrical Engineer, small electric motor design; prefer man with experience in the strictly electrical aspects. Salary, to $10,000 a year. Company will pay placement fee. Location, Massachusetts. W-6822.

Process Engineers, degrees in mechanical, electrical, or metallurgical engineering, with some work experience related to metal working preferred. Should have a minimum of four to five years of industrial experience. Company is specialist in the development and manufacture of nickel-chromium and nickel-copper resistance wire, strip and special castings. Salaries open. Location, New York Metropolitan area. W-6829.

Engineers. (a) Sales and Field Application Engineer for company manufacturing relays and other electro-mechanical specialties, to take over and develop upper New York State territory. Graduate electrical or equivalent plus two to five years' experience. Will service OEM's and work independently. Some established accounts. 40% travel. (b) Creative Design Engineer, graduate in physics or electrical engineering or equivalent plus two to five years' related creative design experience, to design and develop superior functional designs of electro-mechanical, electro-magnetic devices. Will work as key member of a small R & D project team. Salaries open; benefits include profit sharing. Relocation assistance. Location, northern New Jersey. W-6834.

Development Engineer, recent electrical graduate, to develop and design modification of standard products to meet customer's application requirements. Also testing, product improvements, etc. Salary open; benefits include profit sharing. Relocation assistance. Location, northern New Jersey. W-6835(a).

Research Associate for fundamental research in theoretical problems in stress wave propagation in materials; background in applied mathematics or experience in solving boundary-value problems equivalent to Ph.D. status desired. Salary open. Location, Pennsylvania. W-6844.

Engineers. (a) Production Engineer, Components, graduate physics or electrical engineer with experience in production engineering procedures in the components field. Experience in design of pressure transducers or potentiometers is desirable. Salary, to $7800 a year. Company will negotiate placement fee. (b) Designer, Components, experienced in design, detail and layout of instrument type parts for electro-mechanical components. Salary, to $7800 a year. Location, Long Island, New York. W-6848.

Project Engineers. (a) One for Pressure Transducers and Sub Systems, graduate electrical or mechanical engineer, with three to ten years' experience and detailed component knowledge in fields of free displacement, force balance types of pressure transducers, and their combination with servos, machine motors, and true airspeed devices. Will supervise group of engineers, designers and technicians in research and development, product refinement, test equipment design and environmental testing. Salary, $10,000-$13,000 a year. Placement fee and moving expenses negotiated. (b) One for Deposited Film Potentiometers, graduate physicist, metallurgist, electrical engineer, with three to eight years' experience in evaporated or other deposited resistance films. Research and development background with some production engineering experience desired for basic and applied research on evaporated film, potentiometers and the refinement of processes for production. Salary, $10,000-$13,000 a year. Placement fee and moving expenses negotiated. Location, Long Island, New York. W-6849.

Plant manager, graduate mechanical or electrical, plus tool and die making experience on bench desirable, with a minimum of five years as plant manager. Must be experienced as foreman and superintendent of assembly and machining departments of plant manufacturing electro-mechanical devices in mass production through high-speed, low cost manufacturing and assemblies: knowledge of automotive accessories and traffic appliances helpful. Should have knowledge of fabrication of tools and dies used in working brass, steel and aluminum; drawing, piercing, blanking and cupping, etc. Will be responsible for the efficient manufacture of high quality product and constant reduction of manufacturing costs. Salary. $15,000 a year. Location, New England. W-6853.

(Continued on page 63A)

Proceedings of the Computers in Control Systems Conference (May 1958)

THE PAPERS PRESENTED at this conference held October 16-18, 1957 in Atlantic City, N. J., by scientists from the United States, and representatives of the USSR, France, and England, were intended to spotlight the present development in the use of computers in the design process, and as elements of feedback control systems.

It is felt that this international interchange of information will be mutually advantageous to visitors to the conference from abroad, as well as to those from the United States.

The 189-page publication of 31 papers was sponsored by the Feedback Control Systems Committee, AIEE, the Professional Group on Automatic Computers, Institute of Radio Engineers, and the Instruments and Regulators Division, American Society of Mechanical Engineers. Price of publication *T101* is $3.50. Send to:

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Application of Incremental Heat Rates for Economic Dispatch of Power (July 1958)

This 52-page report summarizes the activities of the Working Group on Application of Incremental Heat Rates for Economic Dispatch of Power since it was organized in April 1956.

Included are six papers and a summary of round table discussions, valuable to the power industry, presented at the AIEE Fall General Meeting, October 10, 1957, in Chicago, Ill.

The price for publication S-104 is $3.00. Send to:

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   100 pages, 15 papers and discussions. Price: $3.00.

2. **PROCEEDINGS OF THE EASTERN JOINT COMPUTER CONFERENCE** (Computers with Deadlines to Meet), Dec. 9-13, 1957, Washington, D.C.

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4. **PROCEEDINGS 1957 ELECTRONICS COMPONENTS SYMPOSIUM**, May 1-3, 1957, Chicago, Ill.

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   282 pages, 43 papers. Price: $5.00.

5. **1958 NATIONAL TELEMETERING CONFERENCE**, June 2-4, 1958, Baltimore, Md.

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   482 pages, 30 papers. Price: $7.00.

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This is one of a series of informative messages to acquaint engineers and scientists with the projects of RCA Moorestown.

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The Atlas launch control system complex requires over 200 cabinets of relay logic and newly developed transistorized digital and analog computer circuitry. Of critical significance in the development of the complex are the problems of reliability and accuracy, necessitating the use of advanced transistorized techniques. The challenge of the project is increased by the need for obtaining and integrating information from many associate contractors and by the problems of concurrent research, development and production. The breadth and complexity of the Atlas launch control system are creating stimulating assignments in systems, projects and development engineering.

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FEEDBACK CONTROL SYSTEMS CONFERENCE

The second Feedback Control Systems Conference was held April 21-23, 1954 at Atlantic City, N. J. The papers, as prepared by their respective authors are included in publication S-63. The technical papers and scheduled demonstrations covered the following fields and subjects:

Industrial regulators
Tracer machine tools
Process control
Nucleonics
Aircraft engines
Flight path control
Fire control
Platform stabilization
Flight simulators
Computers
Test equipment
Magnetic Amplifiers
Potentiometers
Gears and dampers

The preceding list indicates a wide range of applications of feedback control as well as the diversity of components.

This 158-page publication, S-63, is available at the price of $3.50 to members and nonmembers from the Order Department

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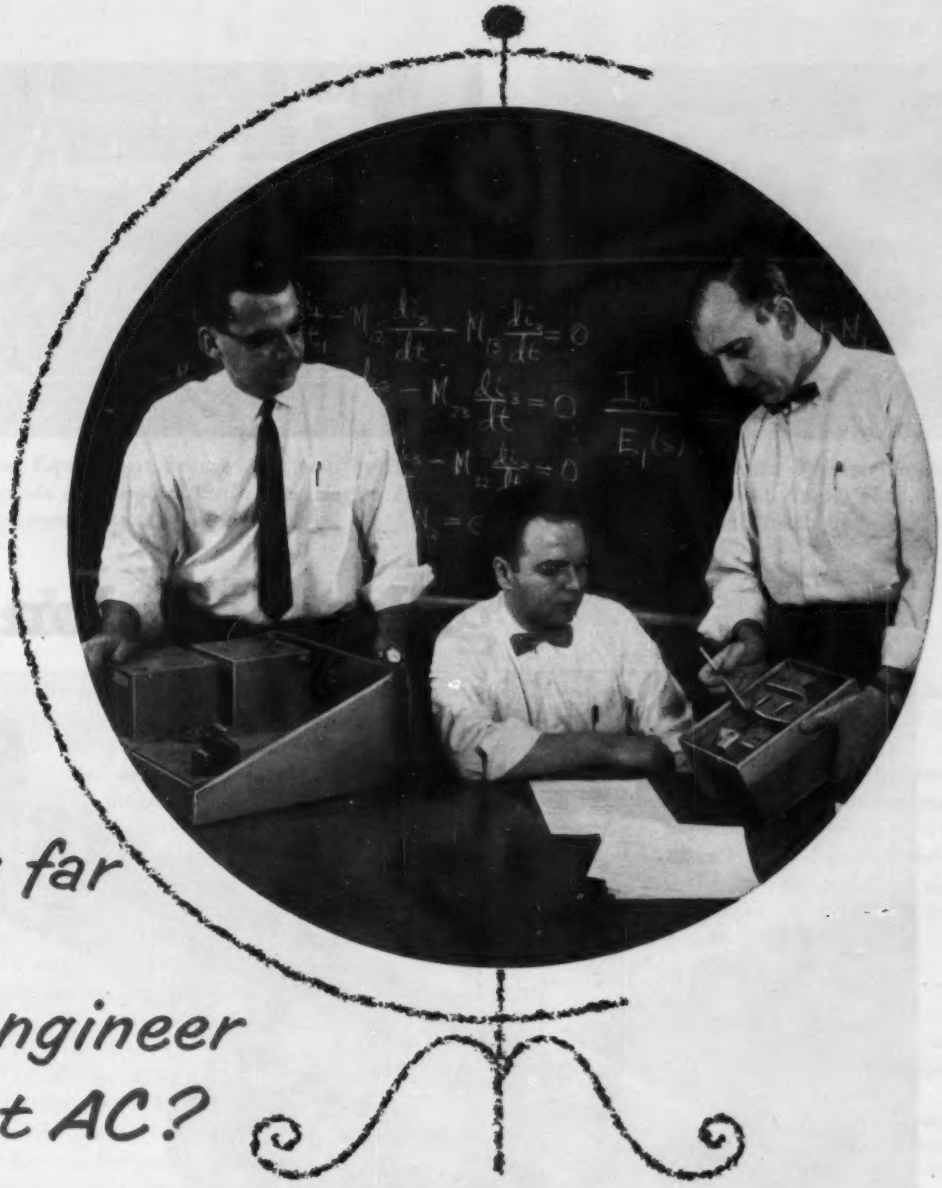

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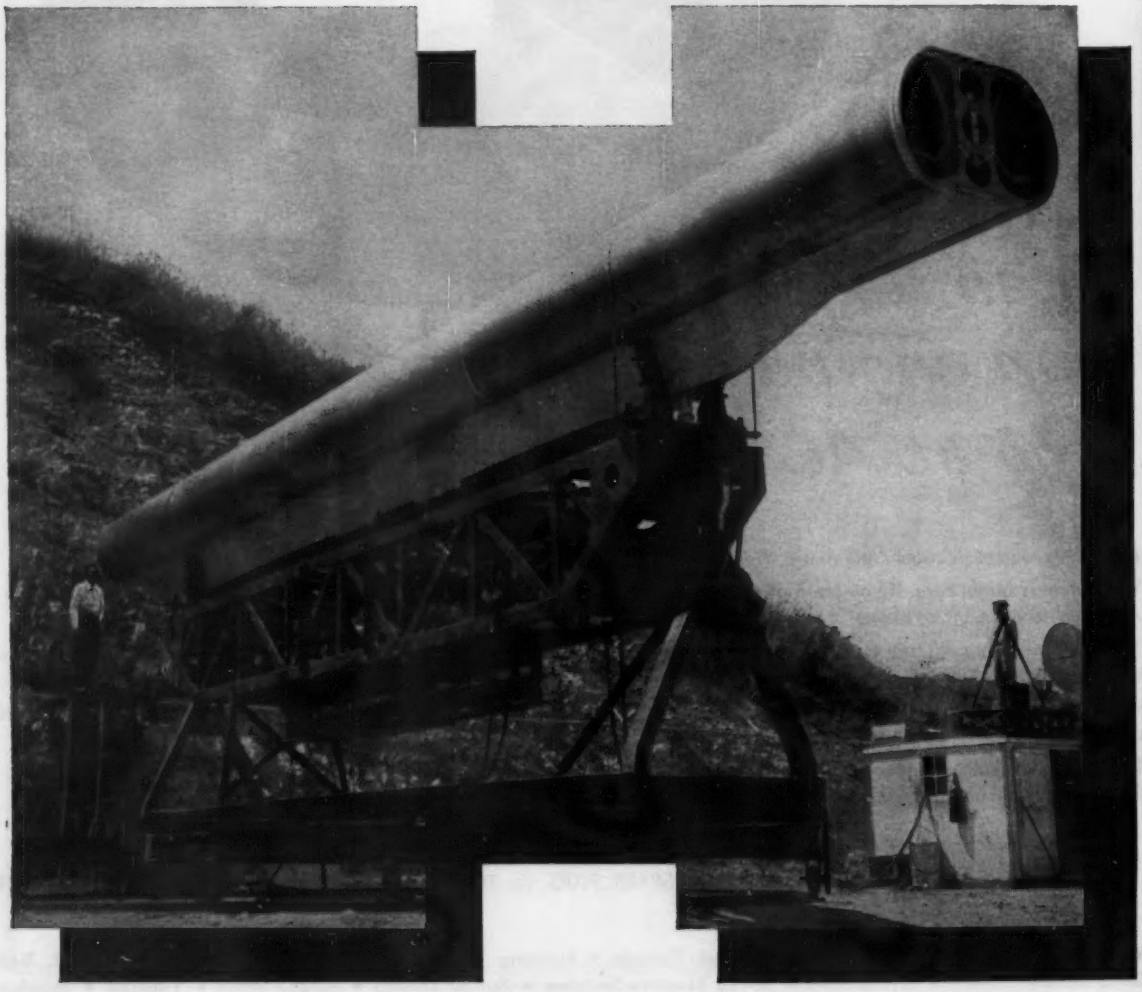

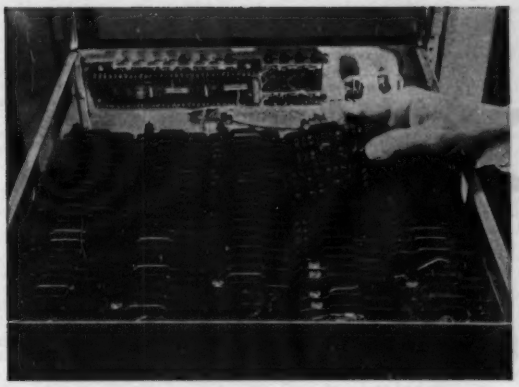

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(Continued from page 56A)

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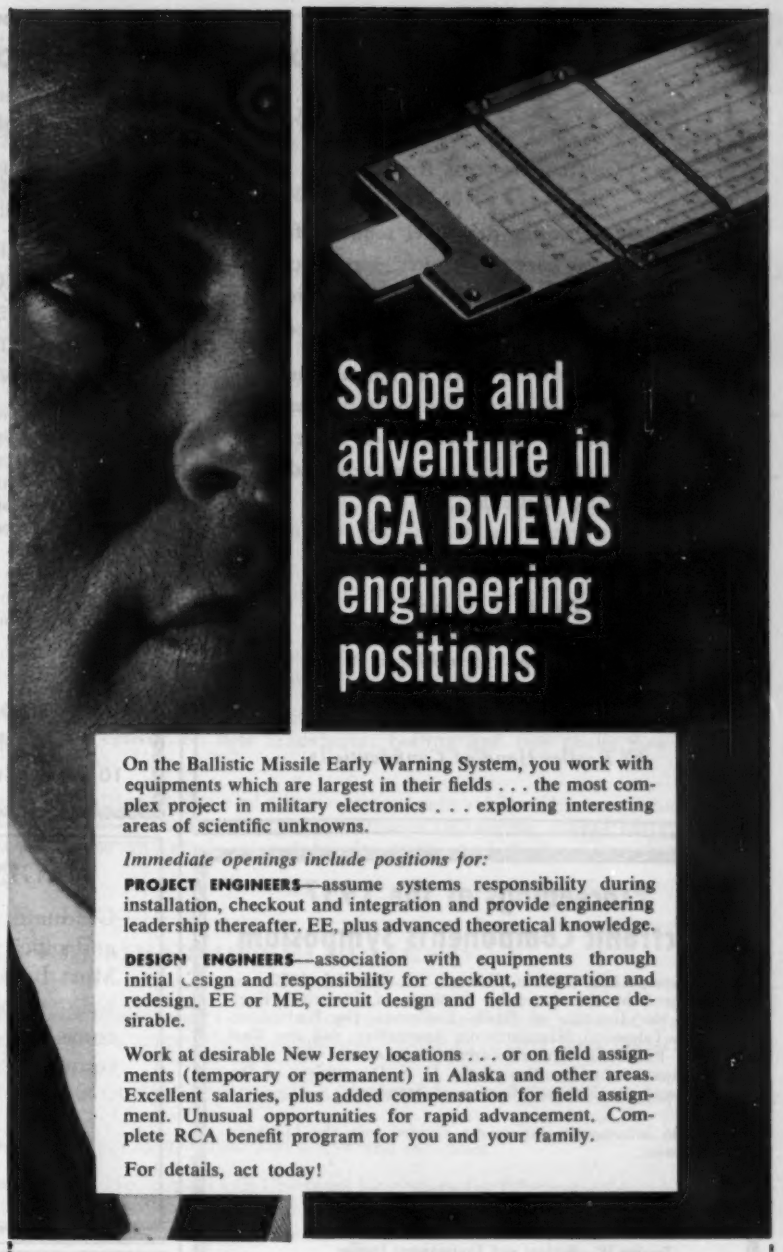

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	W10 Uncased	W10M Cased	W10MT Portable (2-wire cord)	W10MT3 Portable (3-wire cord)	W10H Uncased	W10HM Cased	W10HMT Portable (2-wire cord)	W10HMT3 Portable (3-wire cord)
Input Voltage	115	115	115	115	230	230	230	230
Load Rating (kva)	1.5	1.5	1.5	1.5	1.2	1.2	1.2	1.2
Output Voltage	0-135	0-135	0-135	0-135	0-270	0-270	0-270	0-270
Rated Current (amp)	10	10	10	10	4	4	4	4
Maximum Current (amp)*	13	13	13	13	5.2	5.2	5.2	5.2
No-Load Loss at 60c. (W)	17	17	17	17	17	17	17	17
Dial Calibrations†	0-115 0-135	0-115 0-135	0-135	0-135	0-230 0-270	0-230 0-270	0-270	0-27
Angle of Rotation (deg.)	320	320	320	320	320	320	320	320
No. Turns on Winding	212	212	212	212	430	430	430	430
D-C Resistance of Winding (Ω)	0.63	0.63	0.63	0.63	4.73	4.73	4.73	4.73
Driving Torque (oz.-in.)	30-60	30-60	30-60	30-60	30-60	30-60	30-60	30-60
Net Weight (lbs.)	12½	15	16	16	12	14	15½	15½
Code Word	DOGAL	DOGER	DOGIC	DOGOM	LUTAL	LUTER	LUTIC	LUTOM
Price	$31.00	$44.00	$48.00	$51.00	$33.00	$46.00	$50.00	$53.00

* "0 to line-voltage" connection only
† Portable (MT MT3 HMT HMT3) models are wired for over voltage connection and have corresponding dial scales. Line voltage connection and dials supplied on special order

Replacement Brushes: W10, W10M, W10MT(3) = Type VBT-10, $1.25. W10H W10HM W10HMT(3) = Type VBT-11, $1.25

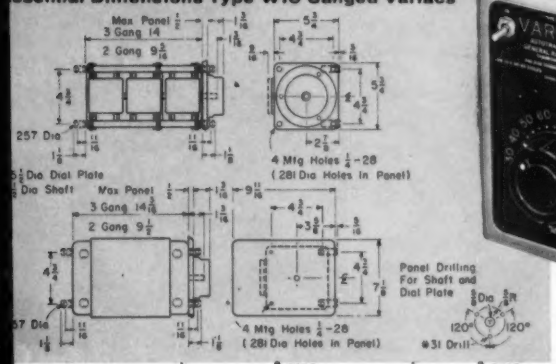
Detailed Dimensional Drawings supplied on request

Type W10 Variac
115-Volt Input; 1.5 KVA; 13 Amp. Max. Current (Type W10H similar except for terminals and dial)

Type W10MT3

Portable model, cased, 3-wire output receptacle, ON-OFF switch, overload breaker and heavy-duty 3-wire line cord and plug. Available in 2- and 3-wire models for either 115- or 230-volt lines

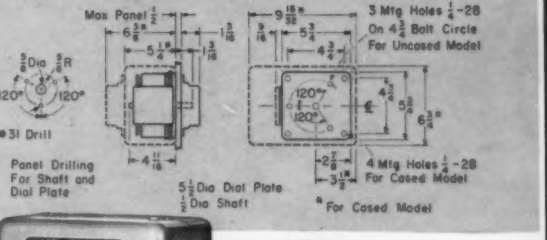
Essential Dimensions Type W10 Ganged Variacs



Essential Dimensions

(Detailed dimensional drawings on request)

Types W10, W10M, W10H and W10HM Variacs



Type W10M

Cased model in gray-enamelled aluminum. Two knockouts on end and one on each side for conduit or armored cable. Simple to install on wall, bench or behind panel

	2-gang W10G2 Uncased			W10G2M Cased	3-gang W10G3 Uncased		W10G3M Cased	2-gang W10HG2 Uncased			W10HG2M Cased	W10HG3 Uncased		W10HG3M Cased
Input Voltage	115	115	230	Same as W10G2	115	230	Same as W10G3	230	230	460	Same as W10HG2	230	460	Same as W10HG3
Load Rating (kva)	3 (Parallel)	2.6 (Delta)	3 (Series)	Same as W10G2	4.5 (Parallel)	5.2 (Y)	Same as W10G3	2.4 (Parallel)	2.1 (Delta)	2.4 (Series)	Same as W10HG2	3.6 (Parallel)	4.1 (Y)	Same as W10HG3
Dial Calibrations	0-10			0-10	0-10		0-10	0-10			0-10	0-10		0-10
Driving Torque (oz.-in.)	60-120			60-120	90-180		90-180	60-120			60-120	90-180		90-180
Net Weight (lbs.)	26½			30½	39½		43½	25			29	37		42
Code Word	GOGAL GANDU			GOGAL BONDU	GOGAL GANTY		GOGAL BONTY	LUTAL GANDU			LUTAL BONDU	LUTAL GANTU		LUTAL BONTY
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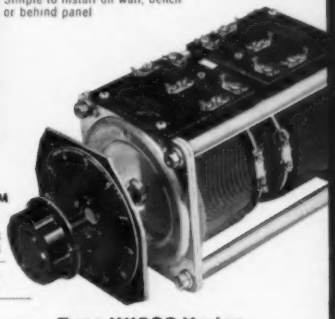

Type W10G2 Variac
2-Gang Type W10 (W10HG2 similar except for terminals and dial)

ANY TYPE W10 Variac or Variac gang can be supplied with ball-bearings. Add suffix "BB" to type number and following surcharge to prices
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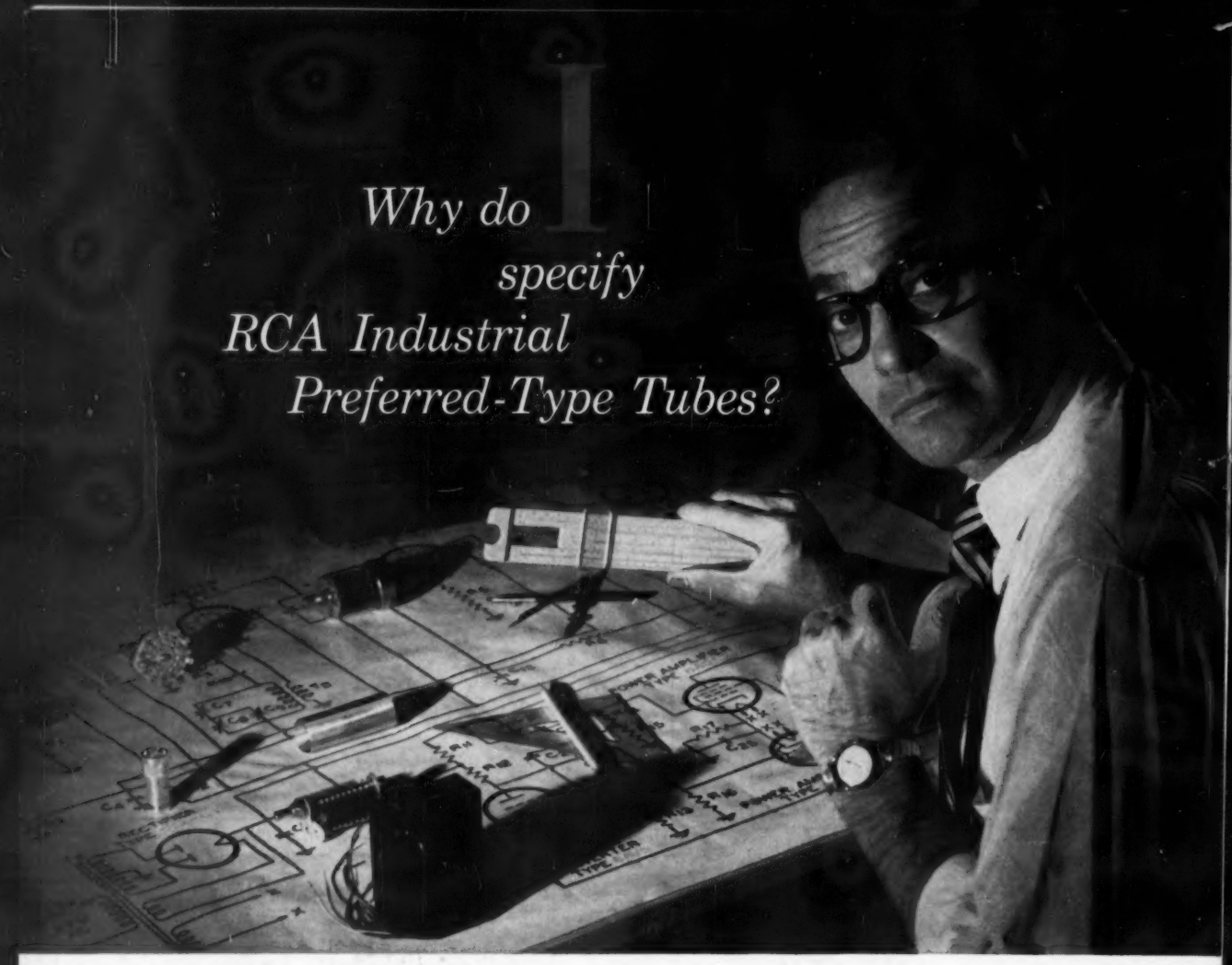

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